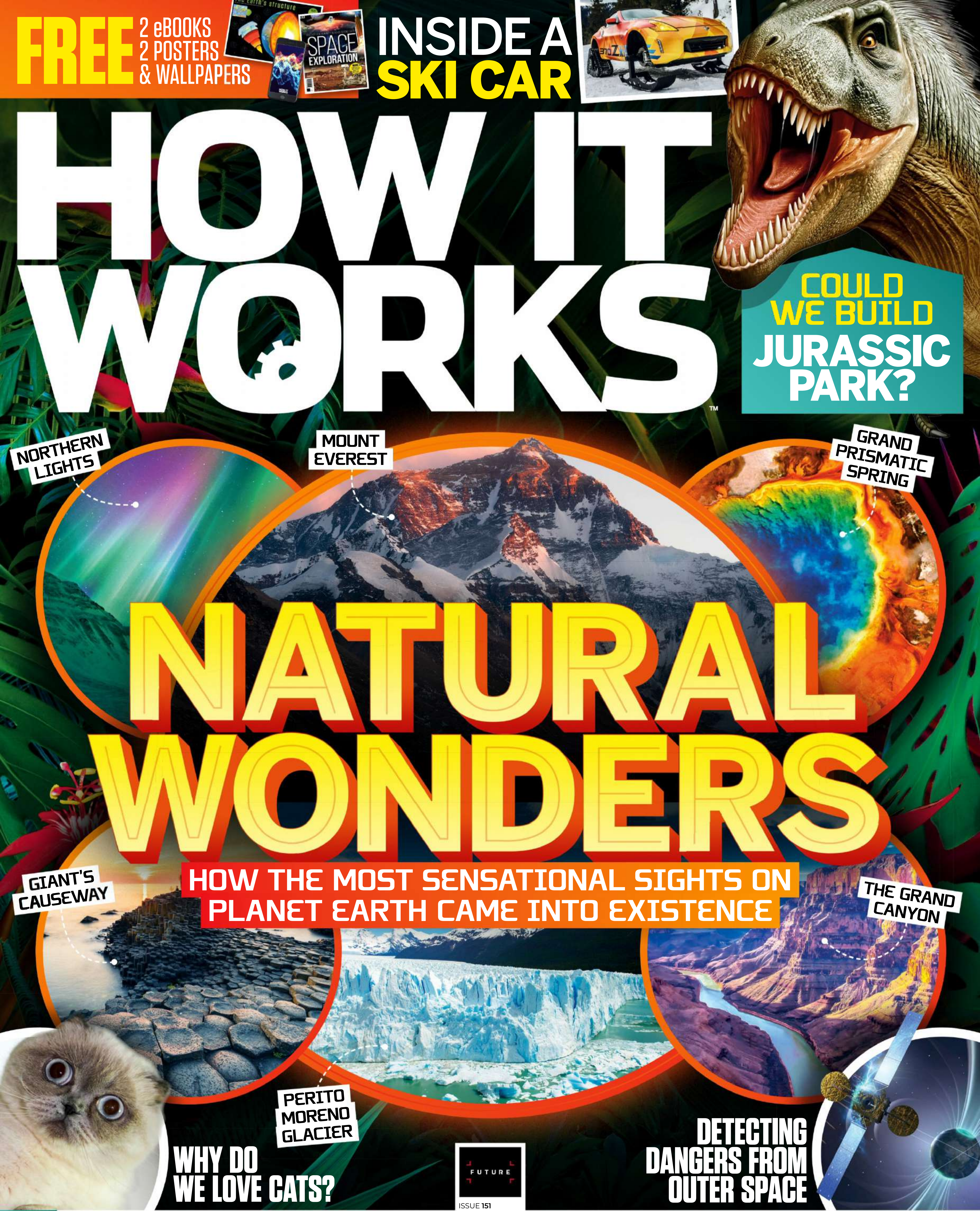

the Earth's structure
SPACE EXPLORATION
HOW IT WORKS

FREE 2 eBOOKS 2 POSTERS & WALLPAPERS

INSIDE A SKI CAR

HOW IT WORKS™

COULD WE BUILD JURASSIC PARK?

NORTHERN LIGHTS

MOUNT EVEREST

GRAND PRISMATIC SPRING

NATURAL WONDERS

HOW THE MOST SENSATIONAL SIGHTS ON PLANET EARTH CAME INTO EXISTENCE

GIANT'S CAUSEWAY

THE GRAND CANYON

PERITO MORENO GLACIER

WHY DO WE LOVE CATS?

FUTURE
ISSUE 151

DETECTING DANGERS FROM OUTER SPACE

+ **BATTLEFIELD MEDICINE** STAR FACTORIES **ALL ABOUT HELIUM** SAVING THE SUEZ CANAL

Smithsonian

CORGI®
WWW.CORGI.CO.UK

CS91304 1903 Wright Flyer
CS91301 Bleriot XL Monoplane
CS91303 Amelia Earhart's
Lockheed® Vega® 5B

PRE-ORDER NOW!

THE HISTORY OF HUMAN FLIGHT IN ONE COLLECTION

©2021 Smithsonian Institution. The name "Smithsonian" and the Smithsonian logo are registered trademarks owned by the Smithsonian Institution.

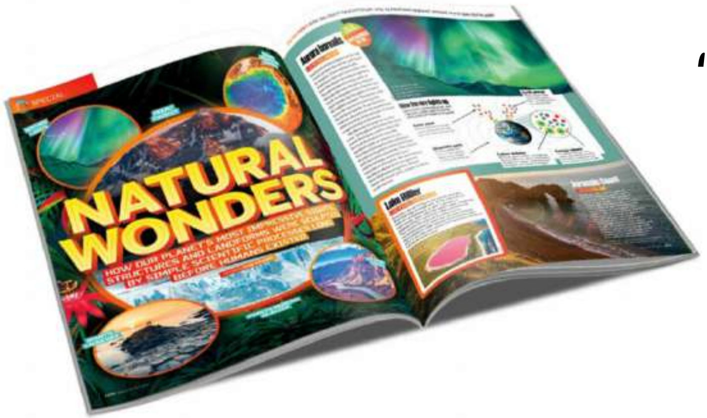
To find out more about the Smithsonian range and the entire Corgi collection, contact our Sales Office now on **01843 233525/sales@hornby.com**

ISSUE **151**

WELCOME

The magazine that feeds minds!

© Getty



> “This cave is home to some of the biggest gems the world has ever seen”
>
> **Natural wonders, page 26**

Meet the team…

Nikole
Production Editor
Where did the idea of mythical creatures come from? Find out the origins of vampires, werewolves and more on page 74.

Scott
Staff Writer
Discover the blood-sucking science behind one of the most prolific parasites and how they are used to heal on page 42.

Baljeet
Research Editor
When a soldier gets injured on the battlefield, they need immediate care. The training and tactics needed are on page 64.

Duncan
Senior Art Editor
What happens when you put a pair of skis on a car? Take a test drive across the snow in Nissan’s one-off 370Zki on page 52.

Ailsa
Staff Writer
Could we recreate Jurassic Park? On page 44, meet the palaeontologist who’s trying to bring dinosaurs back to life.

There must be thousands of truly epic natural wonders that we haven’t talked about in our cover feature in this issue of **How It Works** – and not just the famous filming location for many Hollywood Western movies that is Monument Valley, shown in the image above. We’ve compiled what we think should be included on the sightseeing bucket list of any international traveller or natural historian, and we’ve given you some of the science behind how a few have evolved across human history, and others long prior to that. Turn to page 20 to take in wondrous sights, from the Great Barrier Reef to the relatively unknown yet equally stunning Pamukkale.

Enjoy the issue!

Ben Editor

For exclusive **HIW** news and offers, sign up to our mailing list
howitworksdaily.com/newsletter

FOLLOW US…
howitworksmag
How It Works magazine
@HowItWorksmag

CONTENTS

SPECIAL

26 **Natural wonders**
Discover how the world's most awe-inspiring sights were formed over thousands, millions or even billions of years

AR ZONE!

ENVIRONMENT

36 **Flower power**
Why beautiful blooms are so prevalent in the plant kingdom

42 Inside the body of a blood-sucker

TECHNOLOGY

44 **Could we build Jurassic Park?**
It's nearly 30 years since the cult film came to cinemas: could today's technology allow us to build a dinosaur zoo?

50 Wave power

AR ZONE!

AR ZONE!

TRANSPORT

52 **Meet the ski car**
This one-off from Nissan puts a car on a pair of skis

54 Why we need the Suez Canal

SPACE

AR ZONE!

56 **Detecting space hazards**
The European Space Agency is setting its sights on protecting Earth and astronauts from potential perils

62 Space clouds

AR ZONE!

SCIENCE

64 **Battlefield medicine**
We speak to a combat medic and discover how the military trains personnel to save lives on the front line

70 Making light of helium

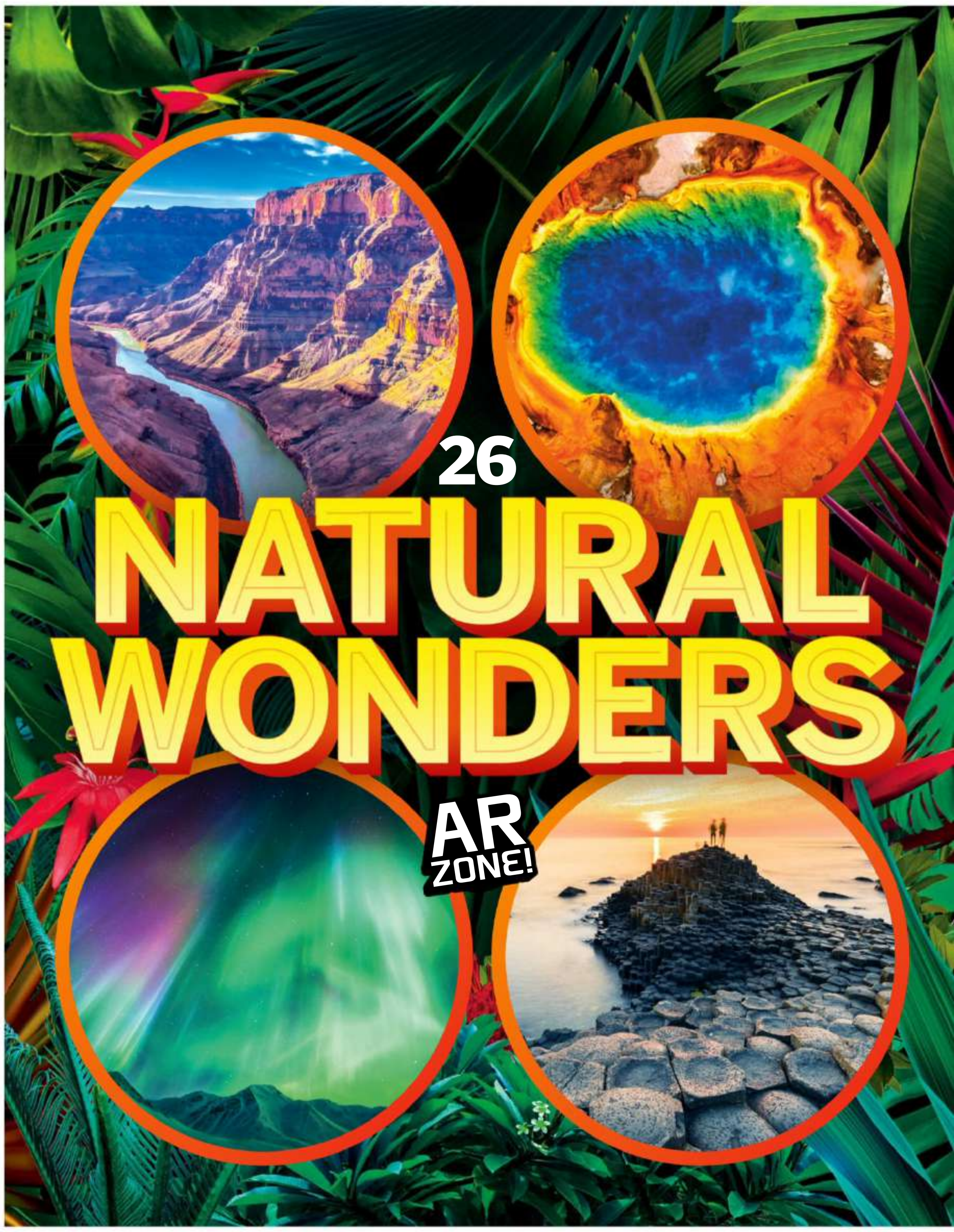
72 How the body makes blood

AR ZONE!

HISTORY

74 **Unmasking mythical monsters**
How It Works digs up the truth behind the origins of unicorns, centaurs, dragons and more

80 How cats became pets


26
NATURAL WONDERS
AR ZONE!

SUBSCRIBE NOW!

Go to **page 24** for great deals

FREE
INSIDE A SKI CAR
HOW IT WORKS
COULD WE BUILD JURASSIC PARK?
NATURAL WONDERS
HOW THE MOST SENSATIONAL SIGHTS ON PLANET EARTH CAME INTO EXISTENCE
WHY DO WE LOVE CATS?
DETECTING DANGERS FROM OUTER SPACE
BATTLEFIELD MEDICINE STAR FACTORIES ALL ABOUT HELIUM SAVING THE SUEZ CANAL

52 Meet the ski car

WIN! A NANOLEAF BUNDLE WORTH £229.98

MEET THIS ISSUE'S EXPERTS…

Andy Extance
Andy is a freelance science writer based in Exeter, UK. He previously worked in early stage drug discovery research, followed by a brief stint in silicone adhesive and rubber manufacturing.

Dr Andrew May
Andrew has a PhD in astrophysics and 30 years in public and private industry. He enjoys space writing and is the author of several books.

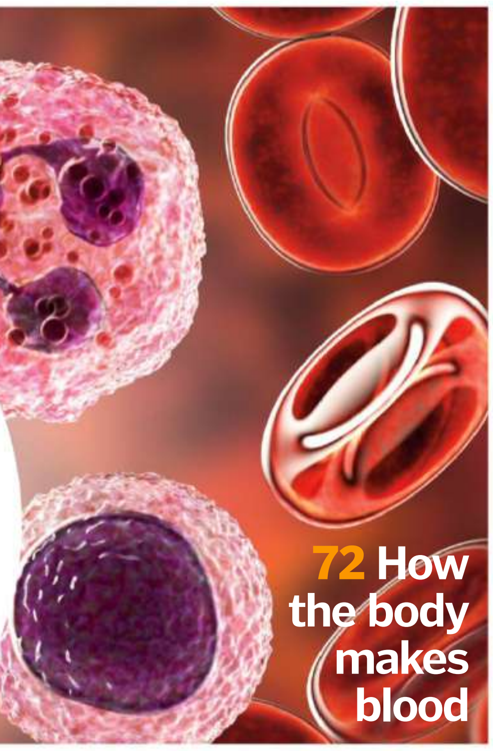
Lauren Eyles
Marine biologist and PADI dive master Lauren has been leading the fight against plastic pollution for over ten years. She's appeared on *BBC Coast*, *Springwatch* and other wildlife programmes.

Jo Elphick
Jo is an academic lawyer and lecturer specialising in criminal law and forensics. She is also the author of a number of true crime books.

Amy Grisdale
Volunteer animal worker Amy has an enormous breadth of experience on animal conservation projects. She specialises in writing about environmental topics.

42 Inside the body of a blood-sucker

80 How cats became pets


72 How the body makes blood

74 Unmasking mythical monsters

AR ZONE!

64 Battlefield medicine

AR ZONE!

56 Detecting space hazards

AR ZONE!

50 Wave power

REGULARS

06 Global eye
Science and tech news from around the world

22 Wish list
The latest gadgets and apps for outdoor activities

51 eBooks and posters
Free **How It Works** digital specials and posters

84 Brain dump
Your questions answered

90 Book reviews

92 Brain gym
Give your brain a workout with our puzzle pages

94 How to...
Make a soap-powered boat

96 Letters
Write to us and have your say!

98 Fast facts

AR ZONE!

44 Could we build Jurassic Park?

AR ZONE!

Scan the QR code with your device's camera or download a free QR code reader app. Many iPhone and Android devices include a QR reader

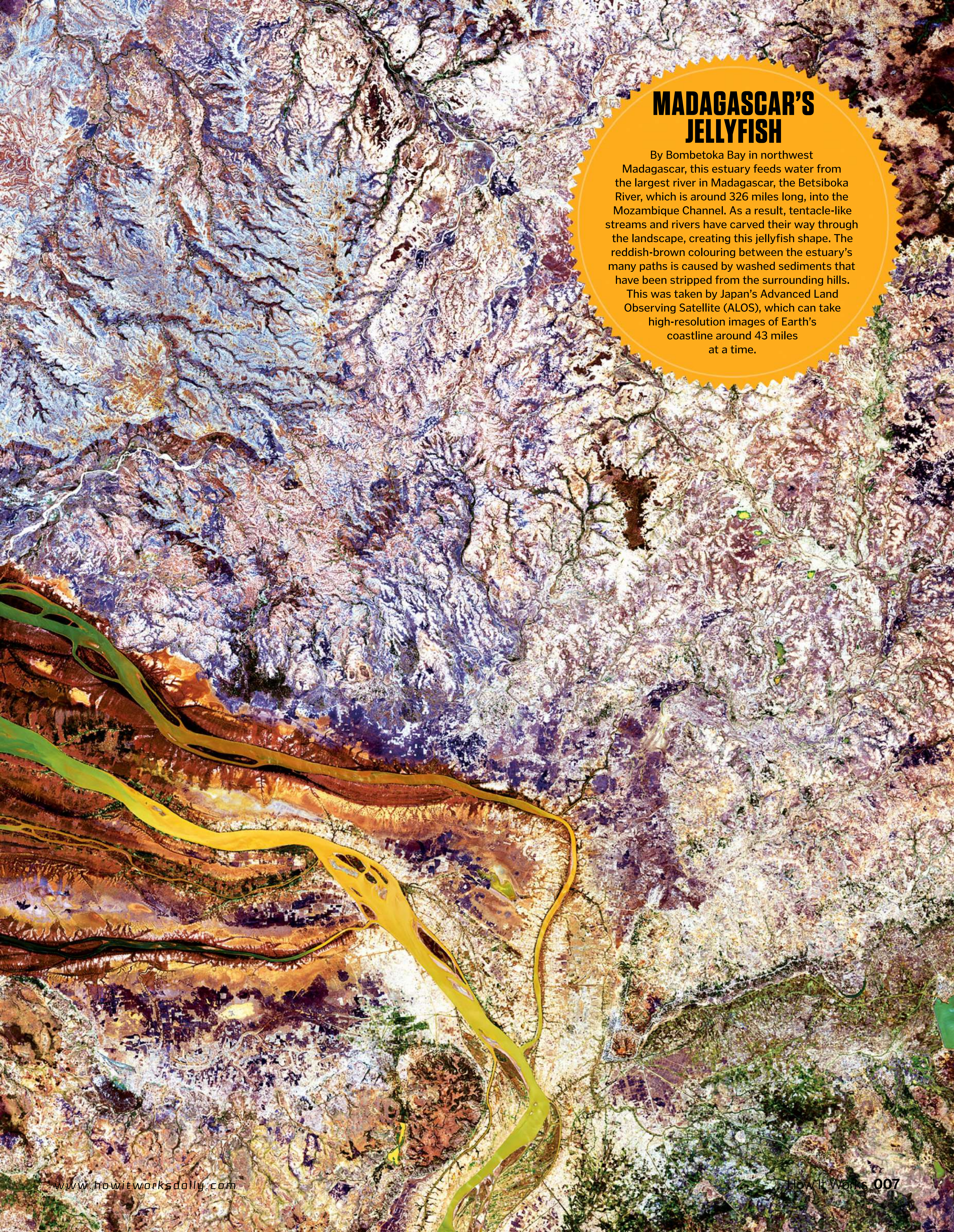
When you see the AR ZONE! logo at the top of a page, use your phone to scan the QR code, which looks like this

Hold your mobile device over the image and watch it come to life! Your device needs to be connected to the internet for this to work

HOW THE AUGMENTED REALITY WORKS

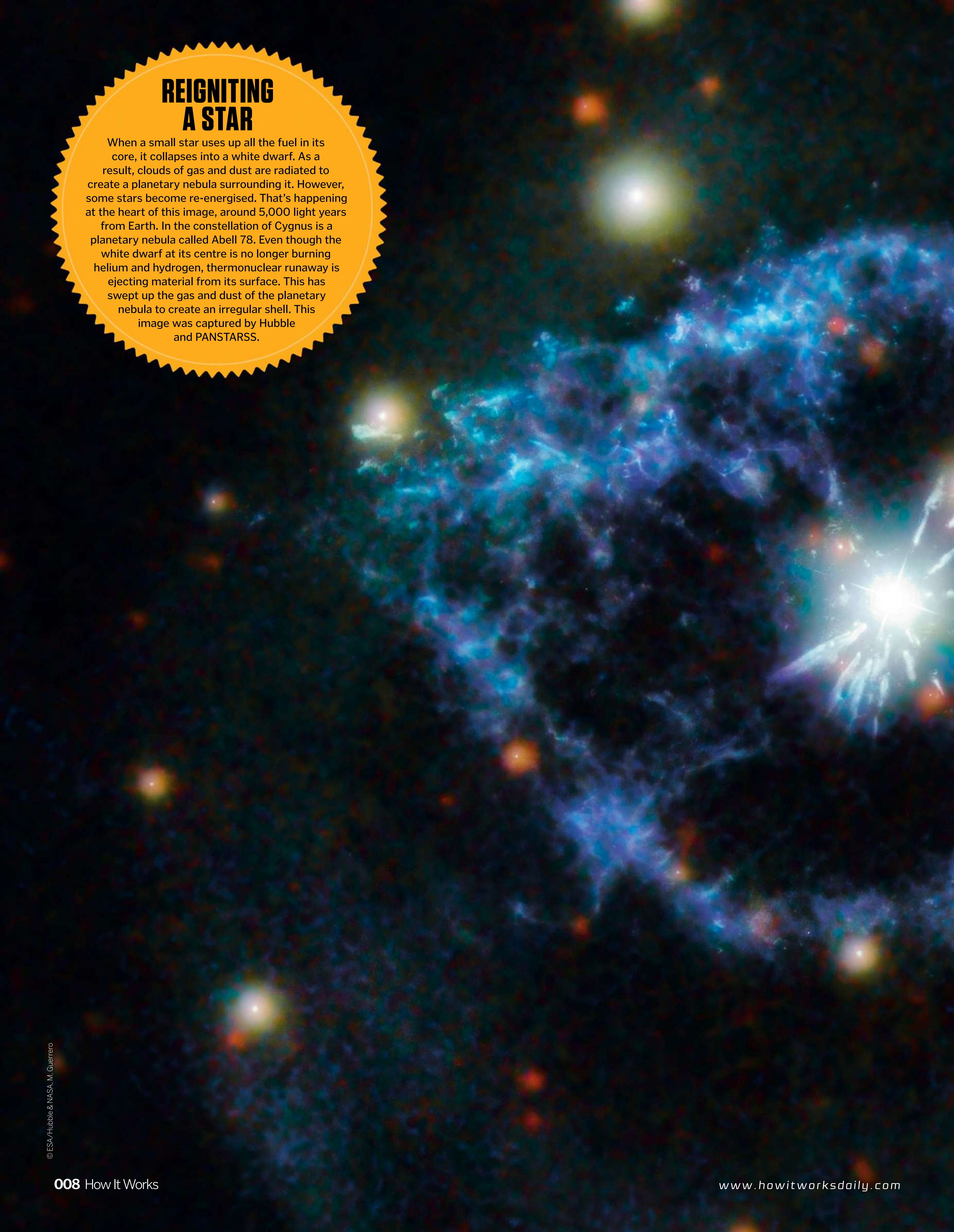
After being launched by the QR code, the app reads anything you point your device's camera at 30 times a second, searching for distinctive shapes we've trained it to recognise. When it sees a familiar picture, it overlays the augmented-reality 3D image we've previously uploaded on your screen.

©JAXA, ESA



MADAGASCAR'S JELLYFISH

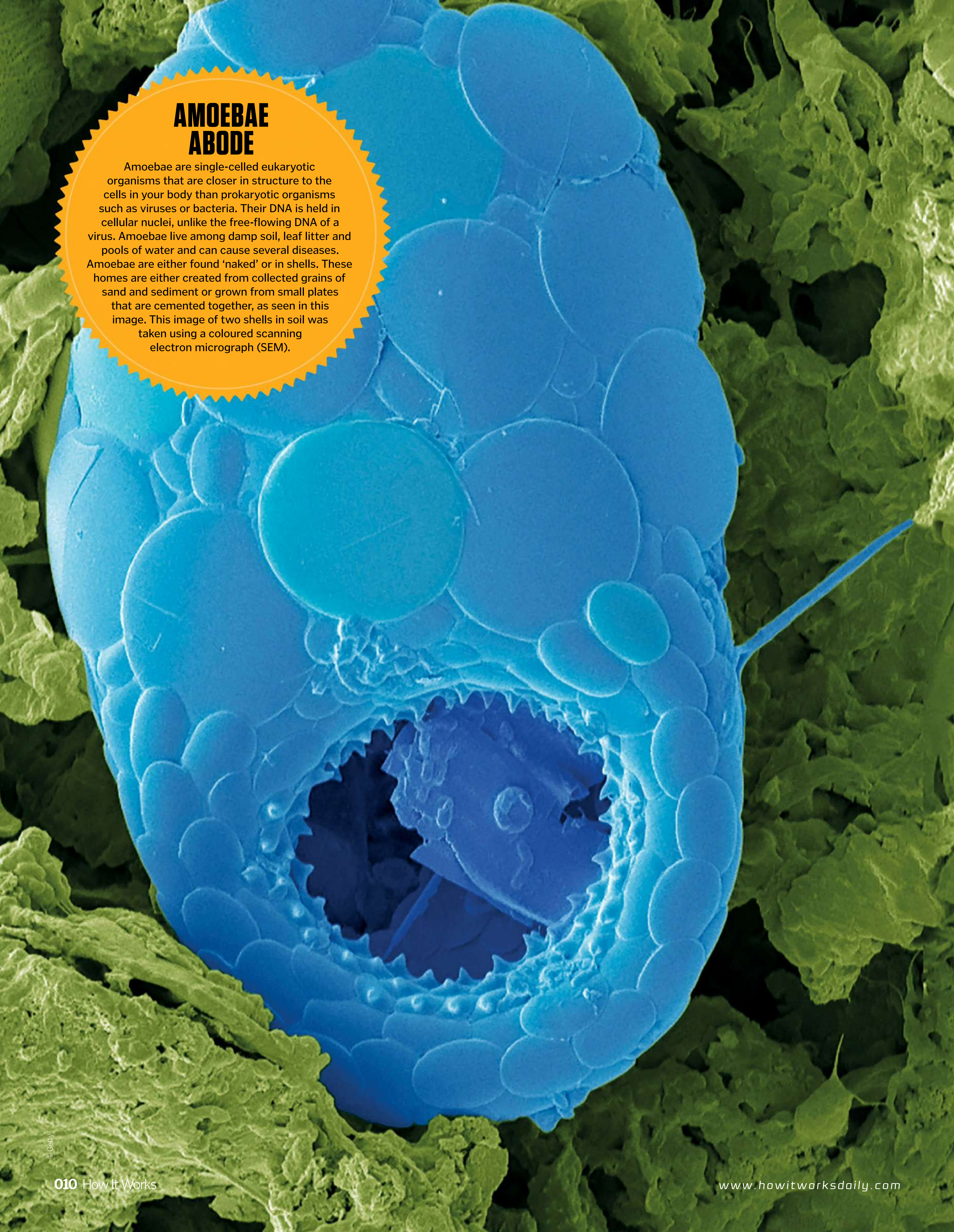
By Bombetoka Bay in northwest Madagascar, this estuary feeds water from the largest river in Madagascar, the Betsiboka River, which is around 326 miles long, into the Mozambique Channel. As a result, tentacle-like streams and rivers have carved their way through the landscape, creating this jellyfish shape. The reddish-brown colouring between the estuary's many paths is caused by washed sediments that have been stripped from the surrounding hills. This was taken by Japan's Advanced Land Observing Satellite (ALOS), which can take high-resolution images of Earth's coastline around 43 miles at a time.



REIGNITING A STAR

When a small star uses up all the fuel in its core, it collapses into a white dwarf. As a result, clouds of gas and dust are radiated to create a planetary nebula surrounding it. However, some stars become re-energised. That's happening at the heart of this image, around 5,000 light years from Earth. In the constellation of Cygnus is a planetary nebula called Abell 78. Even though the white dwarf at its centre is no longer burning helium and hydrogen, thermonuclear runaway is ejecting material from its surface. This has swept up the gas and dust of the planetary nebula to create an irregular shell. This image was captured by Hubble and PANSTARSS.

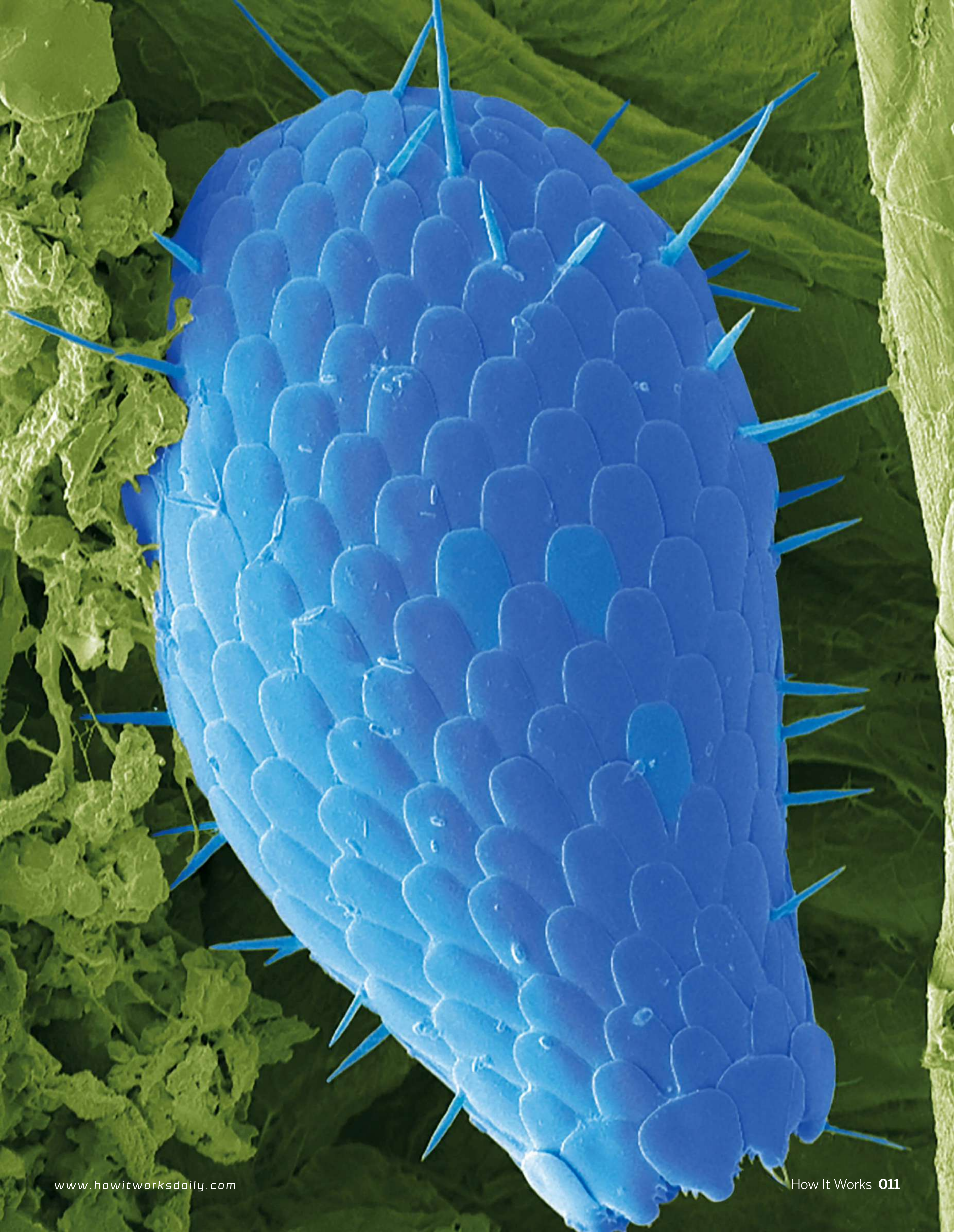
© ESA/Hubble & NASA, M. Guerrero

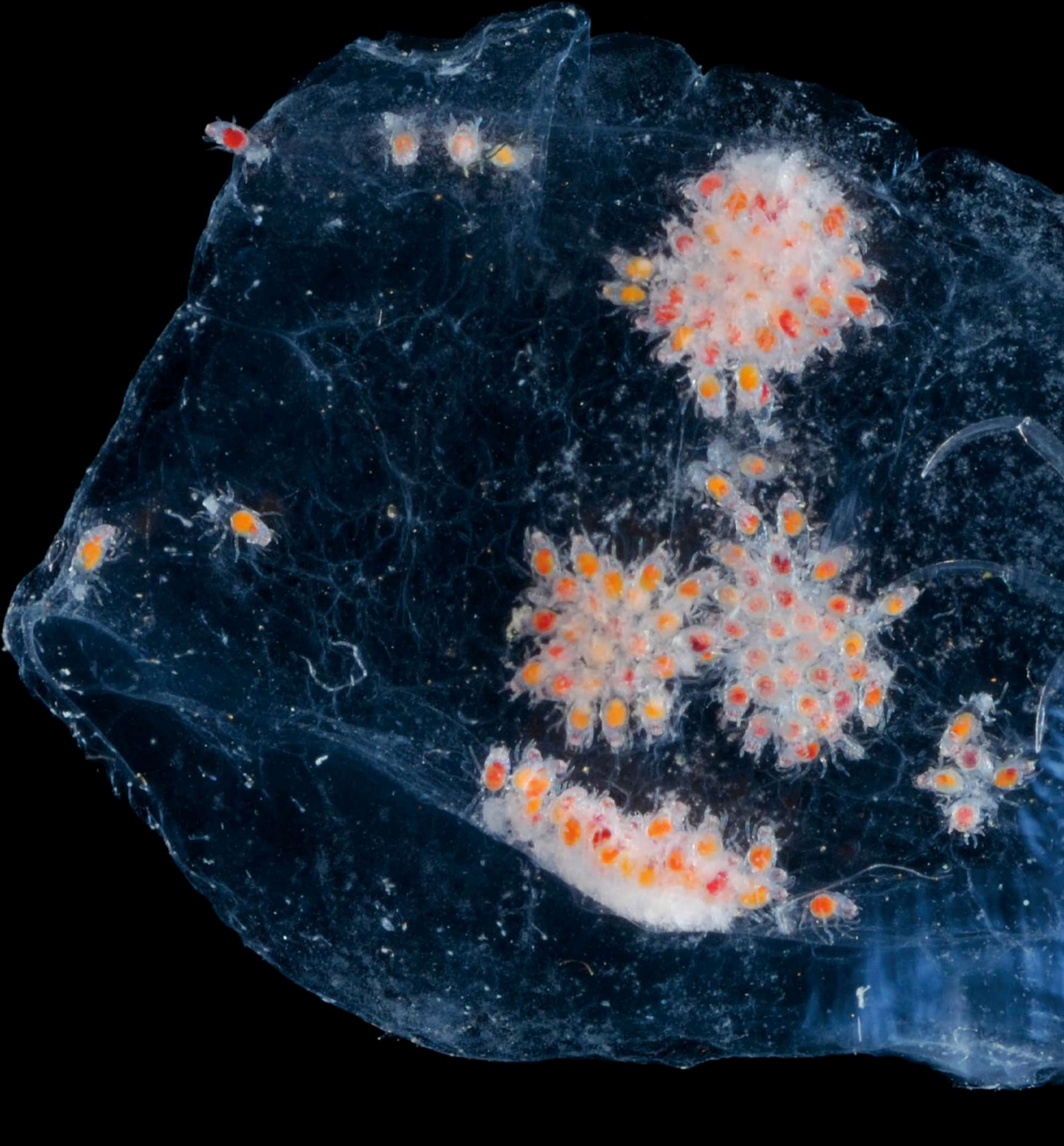


AMOEBAE ABODE

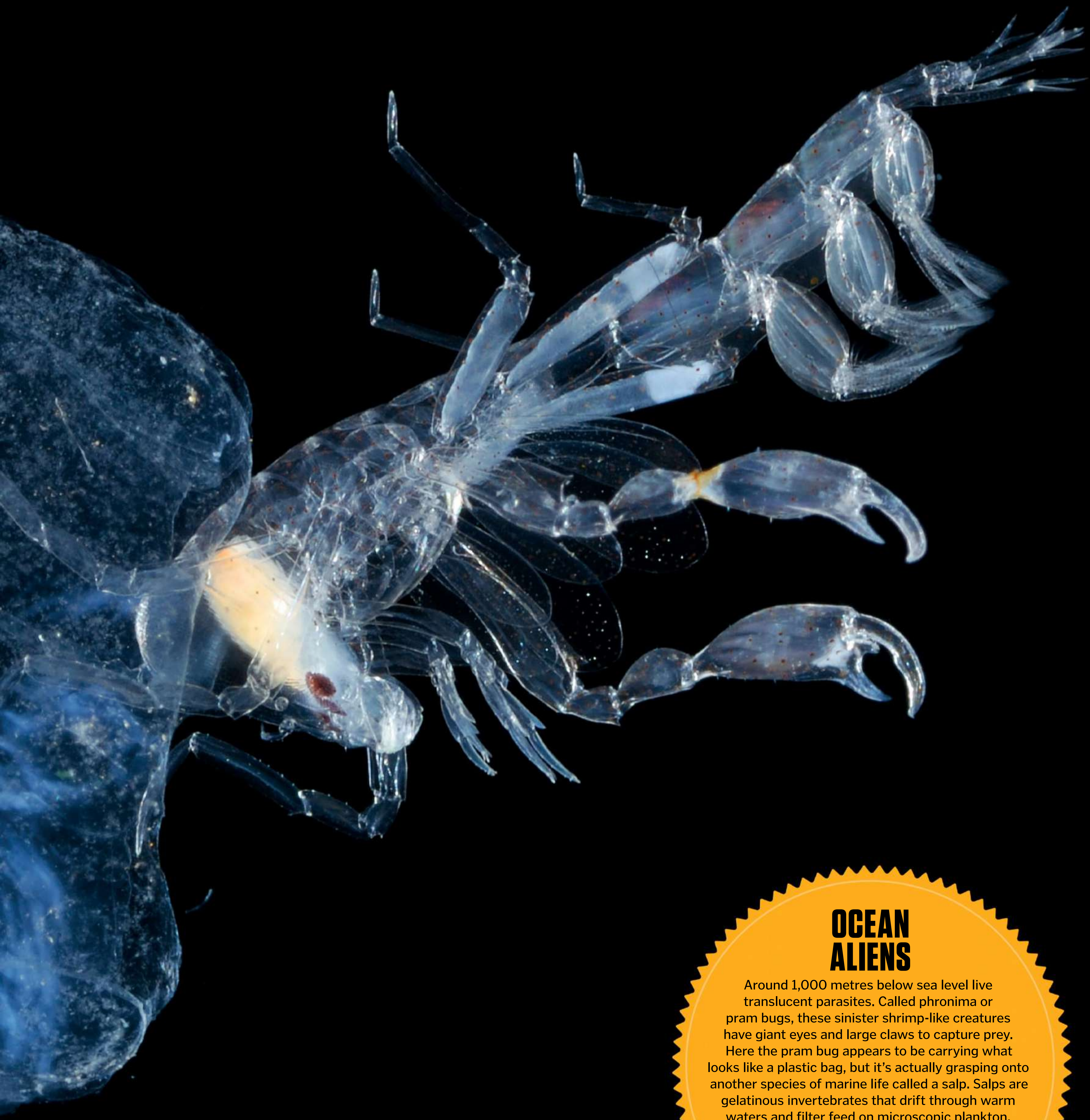
Amoebae are single-celled eukaryotic organisms that are closer in structure to the cells in your body than prokaryotic organisms such as viruses or bacteria. Their DNA is held in cellular nuclei, unlike the free-flowing DNA of a virus. Amoebae live among damp soil, leaf litter and pools of water and can cause several diseases. Amoebae are either found 'naked' or in shells. These homes are either created from collected grains of sand and sediment or grown from small plates that are cemented together, as seen in this image. This image of two shells in soil was taken using a coloured scanning electron micrograph (SEM).

© Getty





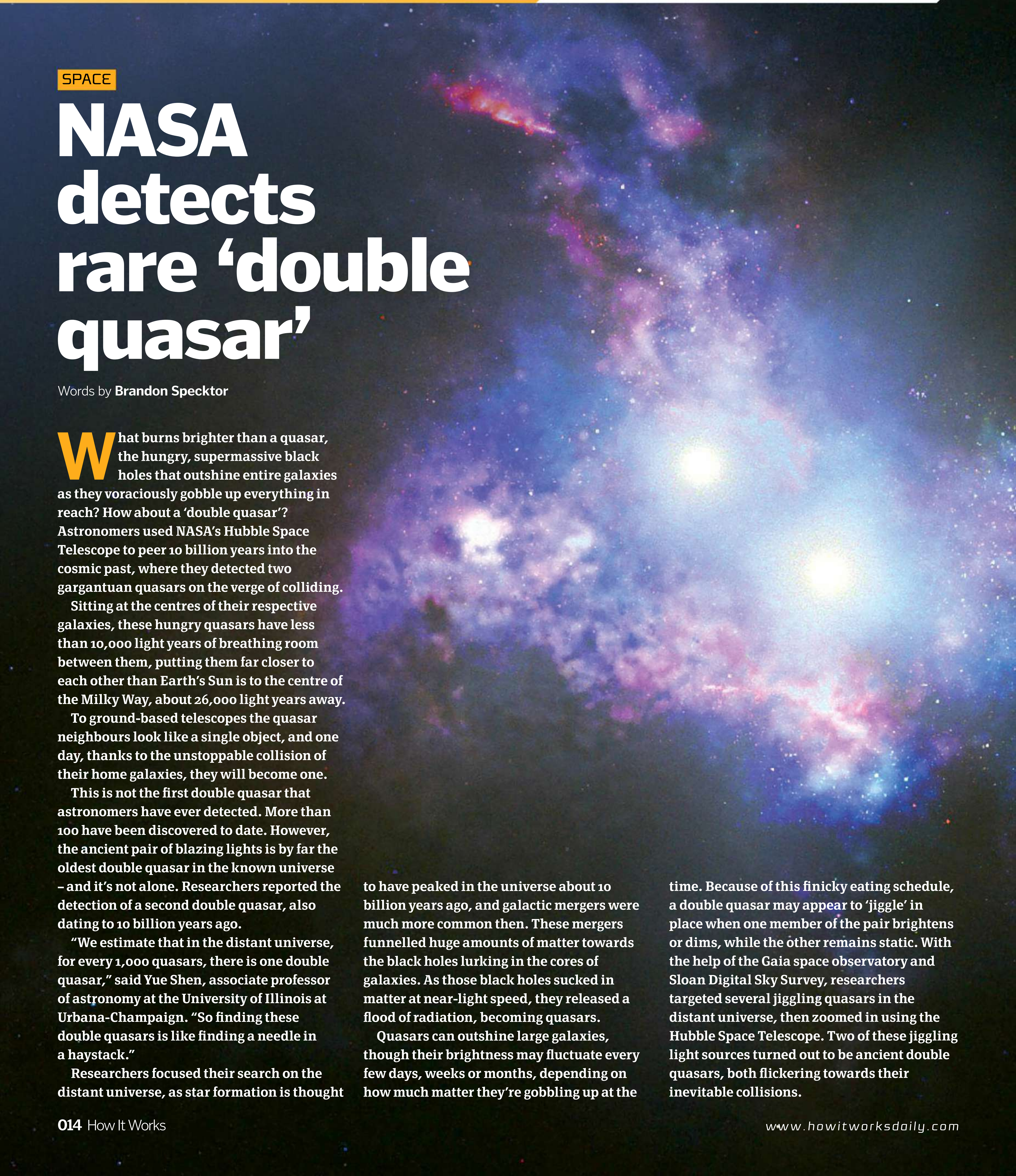
© Alamy



OCEAN ALIENS

Around 1,000 metres below sea level live translucent parasites. Called phronima or pram bugs, these sinister shrimp-like creatures have giant eyes and large claws to capture prey. Here the pram bug appears to be carrying what looks like a plastic bag, but it's actually grasping onto another species of marine life called a salp. Salps are gelatinous invertebrates that drift through warm waters and filter feed on microscopic plankton. However, for the pram bug they also make good baby carriers. The pram bug will ingest the internal organs of the salp and then use its outer casing to carry its young – the orange clusters – around for protection.

IN ASSOCIATION WITH LIVESCIENCE
With over 14 million global monthly users, **Live Science** makes every day a little more interesting by illuminating the fascinating world around us. For the science geek in everyone, **Live Science** breaks down the stories behind the most interesting news and photos on the internet.



SPACE

NASA detects rare 'double quasar'

Words by **Brandon Specktor**

What burns brighter than a quasar, the hungry, supermassive black holes that outshine entire galaxies as they voraciously gobble up everything in reach? How about a 'double quasar'? Astronomers used NASA's Hubble Space Telescope to peer 10 billion years into the cosmic past, where they detected two gargantuan quasars on the verge of colliding.

Sitting at the centres of their respective galaxies, these hungry quasars have less than 10,000 light years of breathing room between them, putting them far closer to each other than Earth's Sun is to the centre of the Milky Way, about 26,000 light years away.

To ground-based telescopes the quasar neighbours look like a single object, and one day, thanks to the unstoppable collision of their home galaxies, they will become one.

This is not the first double quasar that astronomers have ever detected. More than 100 have been discovered to date. However, the ancient pair of blazing lights is by far the oldest double quasar in the known universe – and it's not alone. Researchers reported the detection of a second double quasar, also dating to 10 billion years ago.

"We estimate that in the distant universe, for every 1,000 quasars, there is one double quasar," said Yue Shen, associate professor of astronomy at the University of Illinois at Urbana-Champaign. "So finding these double quasars is like finding a needle in a haystack."

Researchers focused their search on the distant universe, as star formation is thought to have peaked in the universe about 10 billion years ago, and galactic mergers were much more common then. These mergers funnelled huge amounts of matter towards the black holes lurking in the cores of galaxies. As those black holes sucked in matter at near-light speed, they released a flood of radiation, becoming quasars.

Quasars can outshine large galaxies, though their brightness may fluctuate every few days, weeks or months, depending on how much matter they're gobbling up at the time. Because of this finicky eating schedule, a double quasar may appear to 'jiggle' in place when one member of the pair brightens or dims, while the other remains static. With the help of the Gaia space observatory and Sloan Digital Sky Survey, researchers targeted several jiggling quasars in the distant universe, then zoomed in using the Hubble Space Telescope. Two of these jiggling light sources turned out to be ancient double quasars, both flickering towards their inevitable collisions.

An artist's rendering of the double quasar, located in two merging galaxies about 10 billion light years away

© Alamy

Studying merging quasars can help scientists understand the nuances of galaxy formation – and their destruction. As quasars grow, their radiation can generate powerful winds that may ultimately blow all of the star-forming gas out of their way.

When this gas is gone, star formation ends, and the galaxies that house the quasars enter early retirement, slowly waiting for all their old stars to burn out and fade away.

A replica of a painting of bison from the Cave of Altamira in Cantabria, Spain

© Getty

HISTORY

Ancient people created cave art while hallucinating

Words by **Yasemin Saplakoglu**

Stone Age people may have deliberately ventured into oxygen-depleted caves to paint while having out-of-body experiences. In the 19th century, researchers discovered a series of decorated caves that date back between 14,000 and 40,000 years to the Upper Paleolithic era, or Late Stone Age, across Western Europe. Found mainly in Spain and France, they were filled with paintings, many of them in areas that could be accessed only through narrow passageways. The depictions were painted in black and red and primarily showed animals, with some hand stencils, handprints and geometric abstract signs.

But why would people go through the trouble of walking through narrow cave passages to make art? To answer this question, a group of researchers at Tel Aviv University focused on a characteristic of such deep, narrow caves, especially those that require artificial light to navigate: low levels of oxygen. The researchers ran computer simulations of model caves with different passageway lengths that lead to slightly larger 'hall' areas where paintings may be found, analysing the changes in oxygen concentration if a person was to stand in the different parts of the cave burning a torch.

They found that oxygen concentration depended on the height of the passageways, with the shorter passageways having less oxygen. Such low levels of oxygen can induce hypoxia in the body, a condition that can cause headaches, shortness of breath, confusion and restlessness. But hypoxia also increases the hormone dopamine, which can lead to hallucinations and out-of-body experiences. For caves with low ceilings or small halls, the oxygen concentration dipped as low as 11 per cent, which would cause the more severe symptoms.

The researchers hypothesise that ancient people crawled into these deep, dark spaces to induce altered states of consciousness. "Hypoxia might well be a plausible explanation for many of the depiction locations, which are far from the cave mouth and require passing through low, narrow passages," researchers wrote. "We contend that entering these deep, dark caves was a conscious choice, motivated by an understanding of the transformative nature of an underground, oxygen-depleted space."

Caves had a special significance for these ancient civilisations. They were seen as "portals that connect to the underworld,"says Yafit Kedar, a doctoral candidate in the department of archaeology and near-Eastern cultures at Tel Aviv University. The findings suggest that the ancient people sought altered states of consciousness and created cave depictions as "a way to maintain their connection with the entities" of the underworld.

SPACE

Mountains of space dust fall on Earth each year

Words by **Stephanie Pappas**

This gentle rain of space dust consists of bits of comets and asteroids, a total of 4,700 tonnes, far outweighing larger meteorites that hit the planet. Only about nine tonnes of larger space rocks land on Earth annually. Despite the large quantities, it's hard to detect space dust or track its annual accumulation in most places due to precipitation that washes dust away. And in most places, dust originating on Earth swamps dust from space.

But in Adélie Land, Antarctica, near the French-Italian Concordia Research Station, snowfall is very predictable and there is very little terrestrial dust. Over the last 20 years, French National Centre for Scientific Research (CNRS) physicist Jean Duprat and his colleagues have made six expeditions to the area to collect particles. The layers of space dust are well enough preserved in the region for researchers to estimate how much fell year after year.

Researchers dug out large trenches of snow and carried the snow layers in 20-kilogram barrels back to the laboratory at the research station, where they carefully melted the snow and collected the dust particles left behind. They then sorted the particles, removing contaminants like fibres from the researchers' snow gloves.

Extrapolating from the findings in central Antarctica, the researchers found that approximately 4,700 tonnes of these tiny particles, measuring between 30 and 200 micrometres in diameter, drop onto Earth each year – for reference, a human hair averages about 70 micrometres in diameter. That makes tiny particles the most abundant source of extraterrestrial material on Earth.

> "Dust originating on Earth swamps dust from space"

Because much of the space rock that crashes through Earth's atmosphere burns up, the researchers estimated the volume of dust in space that would result in that flux on the planet's surface. They gauged that about 13,600 tonnes of space dust must initially enter the atmosphere each year, meaning only about a third of it reaches the ground.

About 80 per cent of the dust probably comes from comets known as Jupiter-family comets. These are comets with short orbits controlled by the influence of Jupiter's gravity. The other 20 per cent of dust likely comes from asteroids.

Understanding the flux of extraterrestrial material to Earth is important for many fields of astrophysics and geophysics because these space rocks may have brought many elements to the planet. Some theories hold that elements and molecules originating from space rocks may have been crucial to the early development of life on Earth.

Tiny dust particles far outweigh the larger, flashier meteorites that hit the planet

© Getty

ANIMALS

How tarantulas conquered Earth

The Chilean rose tarantula (*Grammostola rosea*), also known as the rose hair tarantula

© Getty

Words by **Mindy Weisberger**

Tarantulas, everyone's favourite hairy spiders, are found worldwide, inhabiting all continents except Antarctica. But how did they become so widespread? To answer this question, researchers went looking for the origins of the tarantula group more than 100 million years ago, building a tarantula family tree based on molecular clues from existing databases. Once they created the tree, they mapped it to a timeline of spider fossils to estimate when – and where – tarantulas appeared and dispersed.

The scientists discovered that tarantulas first emerged during the Cretaceous Period in what is now the Americas. But at the time the Americas were part of the massive supercontinent Gondwana. Ancient tarantula relatives, even if they were homebodies like tarantulas today, likely spread across the joined landmasses, dispersing from the Americas into Africa, Australia and India. Then, after Gondwana broke apart, India separated from Madagascar and collided with Asia, bringing the hairy spiders to that continent, too.

There are only two known tarantula fossils, both preserved in amber: one is from Mexico and is thought to be around 16 million years old, and the other is from Myanmar and is about 100 million years old. Because tarantula fossils are so rare, researchers also collected data from related *mygalomorphae*, the arachnid group that includes tarantulas and other big ground-dwelling spiders, which are better represented in the fossil record than tarantulas.

After constructing a family tree for tarantulas, representing 29 tarantula species and 18 other *mygalomorphae*, the scientists time-calibrated the tree using data from fossils. This enabled the researchers to calculate the ages of tarantula lineages and approximate when the ancestors of modern tarantulas spread over the world.

This new timeline revealed that tarantulas first appeared in the Americas about 120 million years ago. There, the spiders that were ancestors to Africa's tarantulas emerged around 112 million to 108 million years ago. By about 108 million years ago, tarantulas were established in what is now India. India separated from Madagascar between 95 million and 84 million years ago, drifting towards Asia. That slow-motion collision, which began between 58 million and 35 million years ago, brought tarantulas to the Asian continent.

However, before that happened, India's tarantulas diverged into two lineages with different lifestyles: one group of tarantulas were predominantly tree-dwellers, and the other mostly preferred life in burrows.

SPACE

Telescope lasers used in war against space junk

Words by **Rafi Letzter**

Telescope operators figured out years ago how to make the stars stop twinkling. Now a team of Australian scientists wants to use the same technology to track space junk and blast it out of space. Ground-based stations use lasers to track individual pieces of space debris, but those lasers get distorted by the same atmospheric effects that make stars twinkle. Researchers want to use 'adaptive optics' to improve those laser systems.

"Without adaptive optics, a telescope sees an object in space like a blob of light," said Celine D'Orgeville, a scientist at the Australian National University. "With adaptive optics these objects become easier to see, and images become a lot sharper." Adaptive optics essentially cut through the distortion in our atmosphere, making sure we can clearly see the incredible images our telescopes capture.

Adaptive optics work in telescopes by projecting an artificial star onto the sky using a laser of visible light. The system knows what the laser star should look like, so the system can actively determine how the atmosphere is distorting light. It then uses that information to correct the image the telescope is capturing, back-calculating what the light looked like before the atmosphere smeared it.

Down the road, researchers have plans to use lasers like that to move space junk around or even push it out of orbit.

© Celine D'Orgeville/Australian National University

The adaptive optics system built to help track – and one day knock out – junk floating through space

STRANGE NEWS

'Brazil nut puzzle' cracked by researchers

Words by **Ben Turner**

Scientists have finally cracked one of physics' nuttiest mysteries: why do Brazil nuts always find their way to the top of the bag? If you've ever opened a packet of mixed nuts, you may have noticed that you always find the largest nuts, such as Brazil nuts, at the top. Particles of varying dimensions tend to separate by size, with larger items working their way to the top. With the use of time-lapse 3D imagery and some serious packet jostling, scientists have finally shown how the 'Brazil nut effect' works.

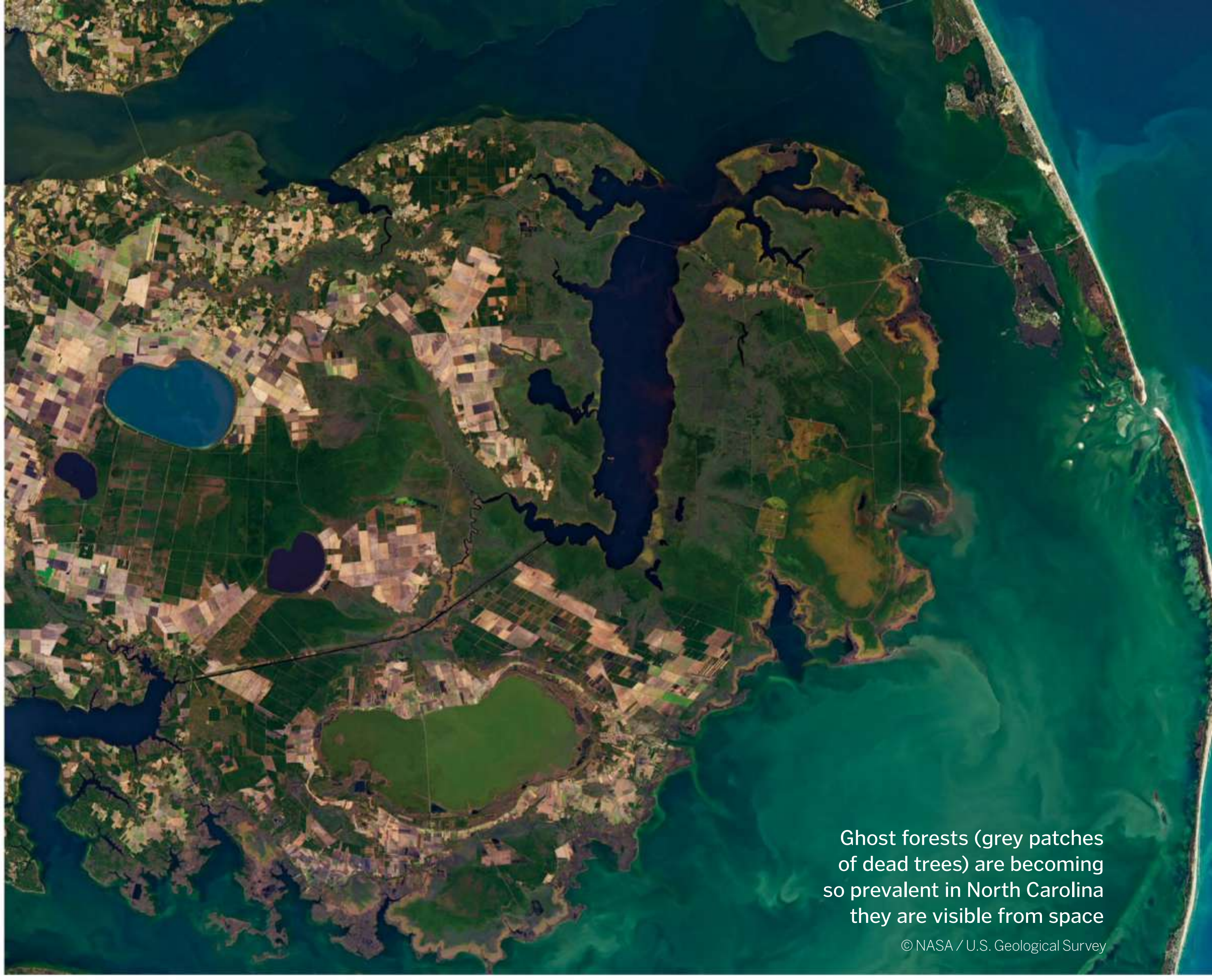
By shaking a mixture of peanuts and Brazil nuts and taking a 3D X-ray scan after each shake, the scientists discovered the forces behind the Brazil nuts' inevitable rise. The secret, they say, is in the larger nuts' orientation.

"The orientation of the Brazil nut is key to its upward movement," said Parmesh Gajjar, a research associate at the University of Manchester. "Brazil nuts initially start horizontal, but do not start to rise until they have first rotated sufficiently towards the vertical axis." Smaller nuts jostle against the sides of bigger ones, making it increasingly likely that the big ones will turn.

Once the Brazil nuts point upwards, more space is freed for smaller nuts to fall down their sides with successive shakes. By the time a typical packet of mixed nuts arrives on grocery store shelves, it has been jostled enough to have all of its bigger contents right at the top.

© Getty

Scientists finally show how the biggest nuts rise to the top



Ghost forests (grey patches of dead trees) are becoming so prevalent in North Carolina they are visible from space

© NASA / U.S. Geological Survey

PLANET EARTH

'Ghost forests' invade the North Carolina coast

Words by **Brandon Specktor**

Climate change has transformed swaths of protected woodland in North Carolina into lifeless 'ghost forests'. Marked by thousands of leafless, limbless trunks, stumps and toppled trees, they've taken over about 11 per cent of the tree cover in the Alligator River National Wildlife Refuge in the past three decades, resulting in tens of thousands of acres of dead greenery.

Die-offs like these are an expected effect of sea-level rise, exposing more land to salty seawater, which literally sucks the moisture out of seeds and soil. However, "it's not just the fringe that's getting wetter," said Emily Ury, a biologist at Duke University in North Carolina.

After analysing thousands of NASA Landsat satellite images taken between 1985 and 2019, Ury and her colleagues calculated that more than 8,500 hectares of trees in the refuge were converted to ghost forests during that period. Remarkably, more than half of the newly killed forests stood more than 0.6 miles inland from the nearest coast, putting them far from the reach of rising tides.

A variety of factors led to the downfall of these inland forests, including hundreds of miles of drainage ditches that funnelled seawater farther inland, but the storm surge that accompanied Hurricane Irene in 2011 proved to be the most devastating. During the surge, a 1.8-metre wall of water gushed more than 1.2 miles inland, flooding everything in its wake.

Alligator River National Wildlife Refuge was still recovering from a five-year drought when the hurricane hit, and the resulting damage was immense. In 2012 alone more than 4,400 hectares of trees turned into 'ghosts', far surpassing the 1,100 hectares of coastal land that was lost to sea-level rise during the entire 35-year period of the study. These vast new patches of drowned and dying trees were clearly visible from space.

As global sea levels rise in response to climate change, storm surges like Irene's are expected to become more destructive, resulting in greater flooding. These surges are "the most pressing short-term problem regarding sea-level rise," says Jacky Austermann, an assistant professor at Columbia University in New York. Lessons learned in North Carolina could help scientists predict and manage the damaging effects of future storm surges around the world.

HISTORY

Pterosaurs had bizarre neck bones

Words by **Laura Geggel**

During the dinosaur age, azhdarchid pterosaurs, soaring reptiles that could grow as large as aeroplanes, supported their absurdly long necks and large heads during flight thanks to a never-before-seen internal bone structure in their neck vertebrae. This unique structure, which looks like the spokes on a bicycle wheel, allowed the largest pterosaurs, such as *Quetzalcoatlus northropi*, which had a wingspan of more than ten metres, to fly with necks that were even longer than a giraffe's neck.

"One of our most important findings is the arrangement of cross-struts within the vertebral centrum [the inner wall of the vertebrae]," said Dave Martill, a professor of palaeobiology at the University of Portsmouth. "It is unlike anything seen previously in a vertebra of any animal."

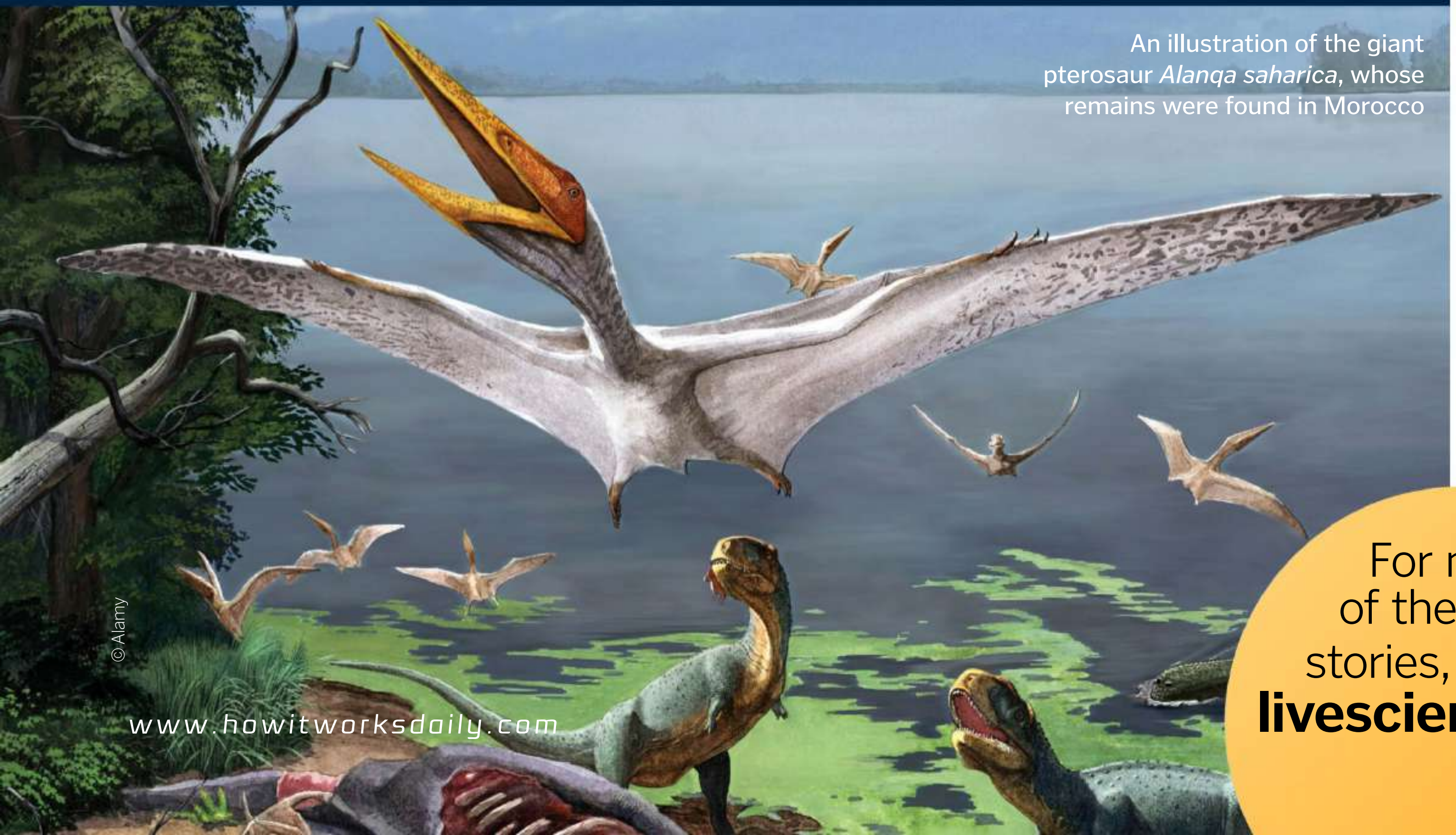
The researchers found that in pterosaurs in the family *Azhdarchidae*, these rod-like structures connected the interior walls of the largely hollow neck vertebrae. These slender rods had an average diameter of 1.16 millimetres, and they were "helically arranged along the length of the vertebrae," Martill said. "Evolution shaped these creatures into awesome, breathtakingly efficient flyers."

Pterosaurs aren't dinosaurs, but lived alongside them after emerging during the Late Triassic Period about 225 million years ago, vanishing from the fossil record at the end of the Cretaceous Period about 65.5 million years ago.

Up until this fascinating discovery, researchers suspected that a pterosaur's neck bones had only a simple tube-within-a-tube structure, Martill said. But this proposed structure likely wouldn't have provided the long neck enough support for the pterosaur's head, which could be longer than 1.5 metres – especially when it grabbed and carried heavy prey through the air while hunting.

"These animals have ridiculously long necks," said Cariad Williams, a doctoral student at the University of Illinois at Urbana-Champaign. In some pterosaur species, the fifth neck vertebra from the head is as long as the rest of the animal's body. "We wanted to know a bit about how this incredibly long neck functioned, as it seems to have very little mobility between each vertebra," Williams said.

To investigate, researchers did X-ray computed tomography (CT) scans of a well-preserved Cretaceous-age pterosaur specimen (*Alanqa saharica*) discovered in Morocco. Results showed the helically arranged, supportive spider web-like lines crisscrossing the insides of the neck vertebrae. Load-bearing calculations of the neck vertebrae showed that as few as 50 of these spoke-like supports increased the amount of weight the neck could carry, without buckling, by up to 90 per cent. These spokes, together with the tube-within-a-tube structure, show how pterosaurs could have captured and carried heavy prey without injuring their long necks.



An illustration of the giant pterosaur *Alanqa saharica*, whose remains were found in Morocco

© Alamy

© Getty

A trillion-tonne iceberg called A68 broke away from the Larsen C Ice Shelf in 2017

PLANET EARTH

Famous Antarctic iceberg finally melts away

Words by **Stephanie Pappas**

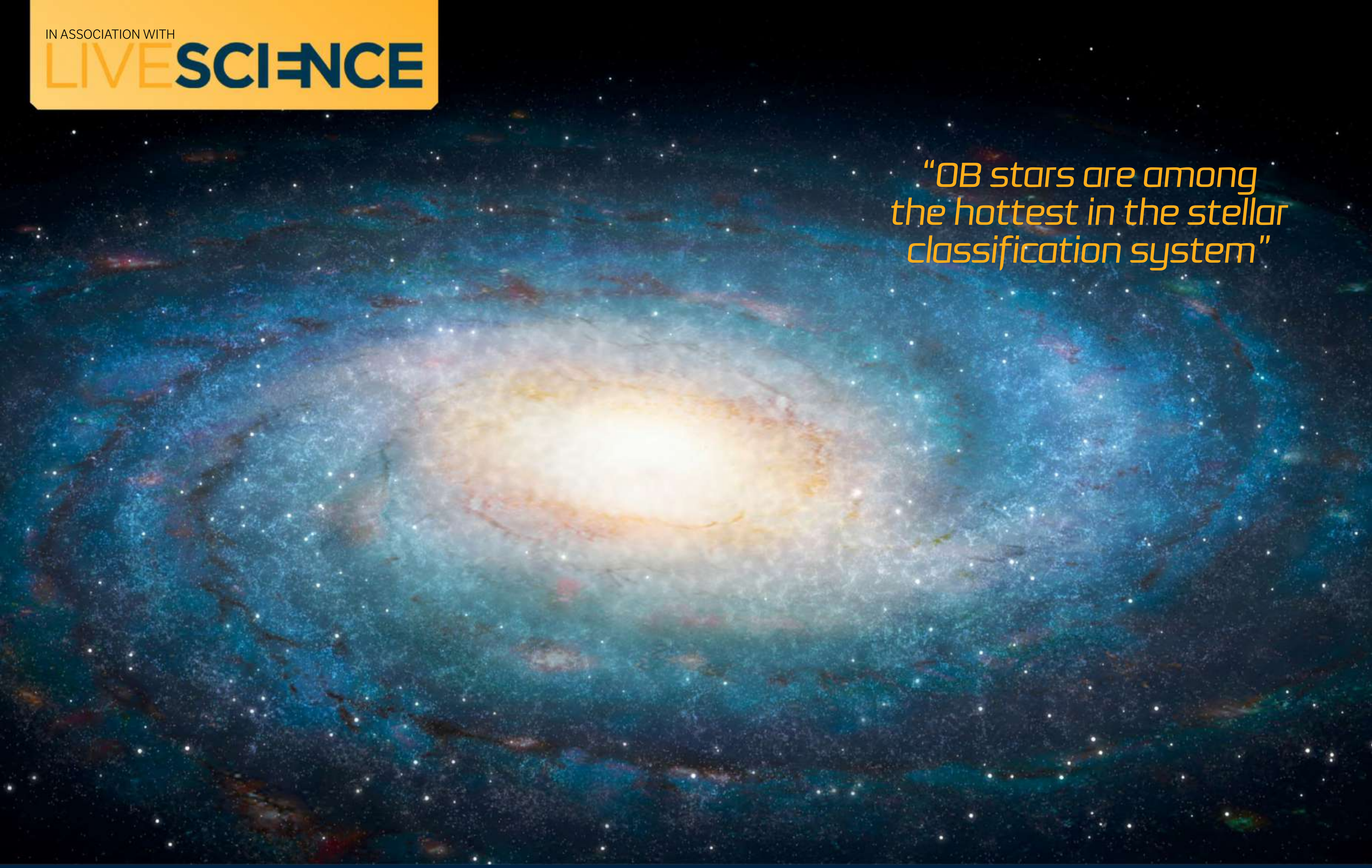
An enormous iceberg whose journeys were probably the most well-documented in history has now melted away to nothing in the Atlantic Ocean. A68 cracked off the Larsen C Ice Shelf on the Antarctic Peninsula in 2017 as one of the biggest icebergs ever. At the time it measured 2,240 square miles.

In the time since the berg has been buffeted about the South Atlantic, curving up towards the island of South Georgia. Warm temperatures and waves then broke it into large chunks. Those chunks have since fragmented into pieces too small to track. The US National Ice Center tracks icebergs that are at least ten nautical miles in length or that have an area of at least 20 square nautical miles. The largest piece of Larsen C no longer qualifies: as of 16 April it measured only three by two nautical miles.

A68 was likely studied more than any other iceberg. Thanks to ample satellite imagery, it was obvious when the enormous iceberg first began to crack under the strain of movement – only a week after it broke free from the ice shelf. Scientists could see the rifts in the ice and the temperature differential in the water that surrounded it. They watched it get stuck on a seamount not far from where it calved and then pirouette towards warmer waters in a current called the Weddell Gyre.

In November 2020 it looked like A68 might crash into the shallows near South Georgia Island, blocking access to the ocean for penguins that roost there. But A68 swung wide, instead gradually getting mushy and fractured as waves stressed it and warm water seeped into and widened small cracks.

For more of the latest stories, head to **livescience.com**



“OB stars are among the hottest in the stellar classification system”

An artist’s Illustration of our galaxy, the Milky Way

© Getty

SPACE

Astronomers detect imminent supernova

Words by **Ben Turner**

Astrophysicists have found a new region of the Milky Way, and it’s filled with searingly hot, bright-blue stars that are about to explode. Researchers were creating the most detailed map yet of the star-flecked spiral arms of our galactic neighbourhood with the European Space Agency’s (ESA) Gaia telescope when they discovered the region, which they have named the Cepheus spur.

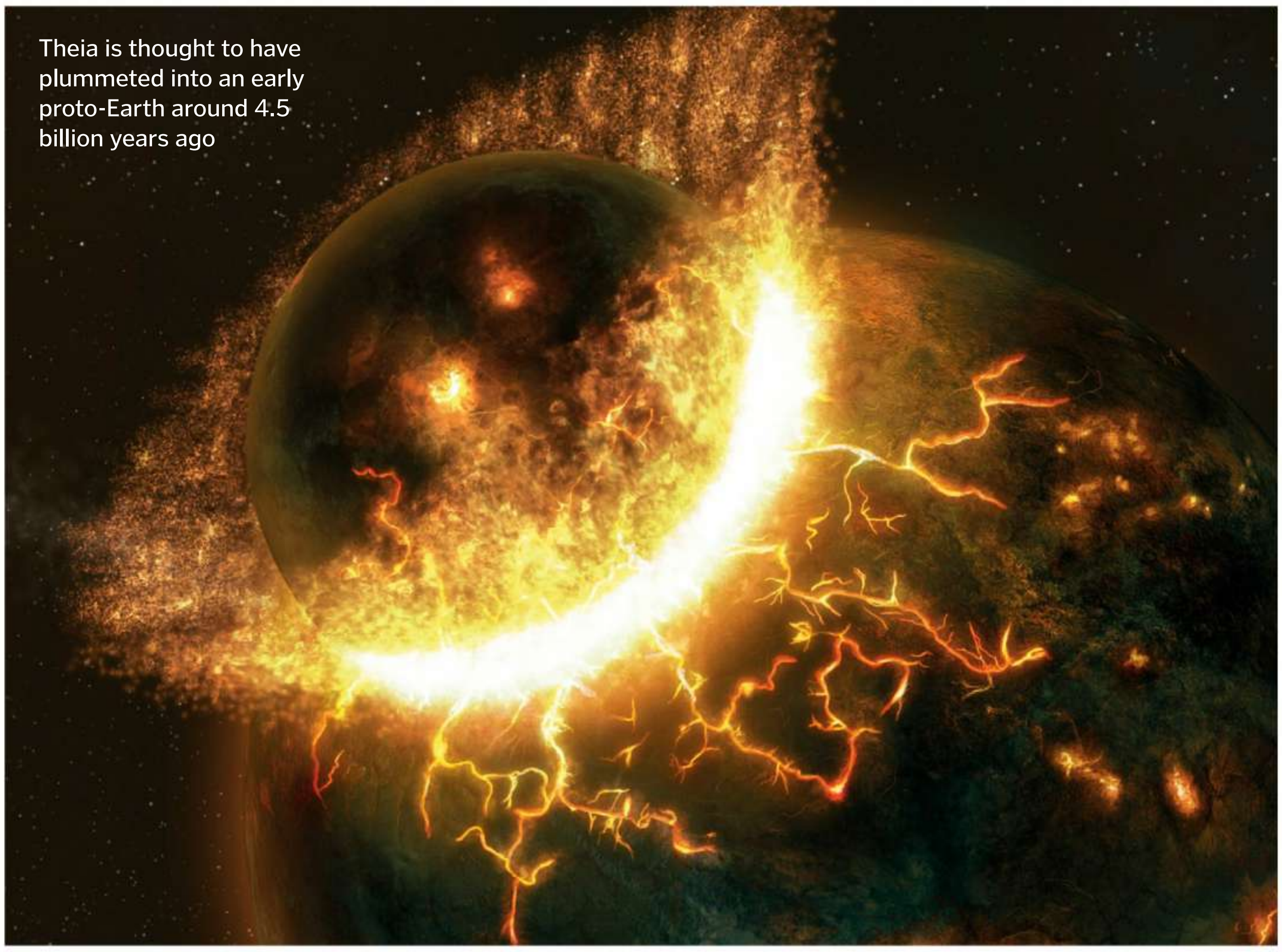
Nestled between the Orion Arm – where our Solar System is – and the constellation of Perseus, the spur is a belt between two spiral arms filled with enormous stars three times the mass of the Sun and coloured blue by their blistering heat.

Astronomers call these giant, blue stars OB stars because they are among the hottest in the stellar classification system. Stars of this type are the rarest, hottest, shortest living and largest stars in the entire galaxy. The violent nuclear reactions taking place inside their hearts make them six times hotter than the Sun. And the enormous stellar explosions that end their lives, called supernovae, scatter the heavy elements essential for complex life far into the galaxy.

“OB stars are rare: in a galaxy of 400 billion stars, there might be less than 200,000,” said Michelangelo Pantaleoni González, a researcher at the Spanish Astrobiology Center. “As they’re responsible for the creation of a lot of the heavy elements, they can really be seen as the chemical enrichers of the galaxy. It’s because of stars like these, dead long ago, that the geochemistry of our planet was complex enough for biochemistry to arise.” Wherever we find blue stars, we find the most active and most ‘alive’ regions of the galaxy.

The researchers compiled their star map by triangulating the stars’ distances to Earth using a technique called stellar parallax. By comparing the apparent positions of the stars, observed from different perspectives during Earth’s orbit around the Sun, astronomers can calculate the distances to the stars themselves. Using this technique, along with data from the ESA’s Gaia telescope, the team mapped out stars at distances beyond any of those charted before and in areas of space previously thought to be empty. “After months of work, we saw this beautiful map for the first time,” Pantaleoni González said. “I felt like an explorer of the Enlightenment tracing the first accurate maps of our world, just now on another scale. I felt extremely humble and tiny seeing how vast our stellar neighbourhood is.”

The scientists proved that the new region was a part of the spiral galactic disc comprising most of our galaxy’s material, and not just a random alignment of stars, by observing them moving consistently in the same direction. The next step for the researchers will be to put additional OB stars into a more precise map, which they hope will produce even more insights into our galaxy’s structures.



Theia is thought to have plummeted into an early proto-Earth around 4.5 billion years ago

© Getty

PLANET EARTH

Protoplanet remnant may hide inside Earth

Words by **Nicoletta Lanese**

A protoplanet slammed into Earth about 4.5 billion years ago, knocking loose a chunk of rock that would later become the Moon. Now scientists say remnants can be found lodged deep inside Earth. If remains of the protoplanet, Theia, did stick around after the impact, that may explain why two continent-size blobs of hot rock now lie in Earth's mantle, one beneath Africa and the other under the Pacific Ocean. These massive blobs would stand about 100 times taller than Mount Everest were they ever hauled up to Earth's surface.

Theia's impact both formed the Moon and transformed Earth's surface into a roiling magma ocean, and some scientists theorise that the blobs formed as that ocean cooled and crystallised. Others think the blobs contain Earth rocks that somehow escaped the effects of the collision and nestled, undisturbed for millions of years, near the planet's centre.

At the Lunar and Planetary Science Conference, Qian Yuan, a doctoral student in geodynamics at Arizona State University, presented an alternate hypothesis. He proposed that after the Moon-forming impact, dense material from Theia's mantle descended deep beneath Earth's surface, accumulating into what we now know as 'the blobs'.

According to Yuan's models, rocks that are 1.5 to 3.5 per cent denser than Earth's mantle would not mix into the surrounding rock. They would sink to the bottom of the mantle, near the inner core. "This crazy idea is at least possible," said Yuan.

A 2019 study supports the idea that Theia's mantle was denser than Earth's by around two to 3.5 per cent. Conclusions of this study were drawn about Theia's size and chemical composition based on an analysis of Apollo Moon rocks, which contained a far higher ratio of light hydrogen to heavy hydrogen than Earth rocks.

To supply the Moon with so much light hydrogen, Theia must have been very large, nearly the size of Earth at the time of impact, and very dry, since water formed in interstellar space would contain a heavy form of hydrogen called deuterium, which Theia lacked. Meanwhile, the interior of the hulking protoplanet would have held a dense, iron-rich mantle.

Per Yuan's theory, while the lighter rocks hurtled into space to form the Moon, chunks of the iron-rich mantle would have barrelled down towards the Earth's core in the wake of Theia's impact, where they settled and formed the enigmatic blobs.

ANIMALS

Endangered monkeys saved from fatal car collisions

Words by **Harry Baker**

Endangered primates frequently killed by cars while trying to cross the road in a national park in Zanzibar have been given a lifeline after speed bumps were put in to slow traffic. Zanzibar red colobuses (*Piliocolobus kirkii*) are small primates with a white coat, red back and black face. They are currently listed as an endangered species, with fewer than 6,000 mature individuals left in the wild. The species is endemic to Unguja, the largest island in the Zanzibar archipelago in the Indian Ocean, and most individuals now live within Jozani-Chwaka Bay National Park.

However, despite being a protected species within a safeguarded area, these small primates are still under threat from human activity. Red colobuses are frequently hit by cars as they try to cross the main road through the park. In response, local authorities added four speed bumps to the roads in the 1990s after pressure from the Wildlife Conservation Society (WCS).

"After the road at Jozani was surfaced but before the speed bumps were installed, a colobus was reported to have been killed every two to three weeks, resulting in perhaps about 12 to 17 per cent annual mortality," said Harry Olgun, a doctoral student at Bangor University in the UK. Since the speed bumps were installed, the rate of collisions between cars and red colobuses has halved.

© Getty

The Zanzibar red colobus is one of the most endangered African primates

WISH LIST

The latest **OUTDOOR** gadgets

© Onewheel

Onewheel Pint

Price: **$950 / £1,020**

www.onewheel.com / www.rideandglide.co.uk

At only around 69 centimetres long, the Onewheel Pint is one of the most compact modes of transport out there. The skateboard-segway combo uses a single battery-powered wheel sandwiched between two sensory footpads to control speed and direction. At the front footpad of the Pint is a smart light system that indicates battery life, in-ride alerts and much more. This gadget can tackle tough terrain and top speeds of 16 miles per hour. On a single charge this one-wheeled wonder has a range of between six and eight miles.

© NEMO Equipment Inc

Stargaze Recliner Luxury Chair

Price: **$219.95 / €249.99**

www.nemoequipment.com

Combining the comfort of a hammock and portability of a camping chair, the Stargaze Recliner is the latest in outdoor seating innovation. This robust chair is dynamically suspended to create the fluid swing of a hammock while remaining sturdy with its aircraft-grade aluminium frame. The recliner will tilt back automatically as you lean into it, returning to its original position as you move forward. It also folds into a compact carry bag for easy transport.

Contigo Thermalock

Price: **From £20 (approx. $27.50)**

www.mycontigo.com

If you're outdoors for long periods of time, then a good thermal travel mug is a must. This Thermalock vacuum-insulated stainless-steel travel mug by Contigo promises to keep your hot drinks hot for up to 30 hours and keep cold beverages cool for 45 hours. The 740-millilitre bottle locks in the drink with its leak-proof design. The 360-degree pour spout is easily removable and dishwasher safe.

© contigo

© AirPop

Active+ Halo Smart Mask

■ Price: **£149.99 (approx. $206)**
www.airpophealth.com

Masks are now commonplace in society, and will likely remain so for some time yet, so making sure you have a comfortable and effective mask is paramount. However, AirPop has gone a step further, creating high-tech 'air wearables' so you can monitor your environment. Offering not just high-efficiency filtration, the Active+ mask also comes with the intuitive Halo Sensor. This sensor monitors the air pollution and quality around you via the companion app and alerts you when it's time to change the filter. It can also record a lot more information, such as your breathing rate and volume and the amount of particulate matter (pollution) blocked.

SolarPanel 5+

■ Price: **£79.99 / $89.95**
www.bioliteenergy.com

Whether you want to keep all your gadgets topped up with power while you're on a hike or you're just sitting in a park on a socially distant meet up, solar panel chargers are a great way to harness some energy. The SolarPanel 5+ by BioLite is a compact solar charger equipped with 3,200mAh battery storage to deliver five watts of usable power via USB. To make sure it can sit in the sunlight, the charger also comes with a 360-degree stand. It's slim and simple design makes it easy to fit into any backpack for outdoor activities.

© BioLite

Flluid E-Bike

■ Price: **From $4,895 / €4,995**
www.fuell.us / www.fuell.eu

If you want to upgrade your cycling experience, the Flluid E-Bike by Fuell might be a good place to start. As an electrically assisted bike, the two removable batteries provide enough power for a range of up to 125 miles, and the bike can reach around 15 miles per hour. The bike also features an easy-to-read colour display indicating battery life, distance, speed and one of the five levels of assistance provided by the batteries.

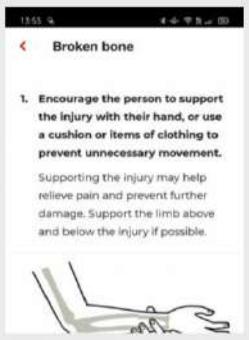
© Fuell

APPS & TOOLS

First aid by British Red Cross

■ Developer: **British Red Cross**
■ Price: **Free / Google Play / App Store**

Stay safe with this app of simple videos, guides and life-saving advice. No internet connection is needed for access in remote areas.



13:55

Broken bone

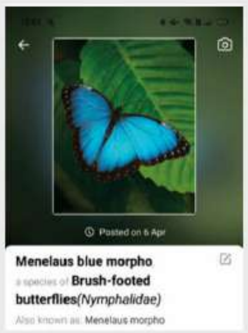
1. **Encourage the person to support the injury with their hand, or use a cushion or items of clothing to prevent unnecessary movement.**

Supporting the injury may help relieve pain and prevent further damage. Support the limb above and below the injury if possible.

Picture Insect

■ Developer: **Next Vision Limited**
■ Price: **Free / Google Play / App Store**

Just snap a picture of an insect and this identifies it as one of the 1,000 species in its database. Also, you can create a collection of insects you've seen.



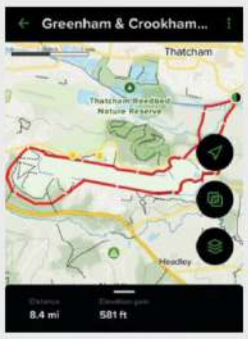
Posted on 6 Apr

Menelaus blue morpho
a species of **Brush-footed butterflies***(Nymphalidae)*
Also known as: Menelaus morpho

AllTrails: Hiking, Running & Mountain Bike Trails

■ Developer: **AllTrails**
■ Price: **Free / Google Play / App Store**

There are more than 100,000 routes to explore and a whole host of features, such as planning your route and recording your journey.



iNaturalist

■ Developer: **iNaturalist**
■ Price: **Free / Google Play / App Store**

Get connected with more than 400,000 scientists and naturalists. Learn to identify different species of plants and animals and record your observations.

Exploring All
10,774
OBSERVATIONS
2,183
1,283
1,534
RG

TIME LIMITED OFFER

SUBSCRIBE TODAY AND SAVE UP TO 60%

HOW IT WORKS
HOW TO THINK YOURSELF SMART
CAN WE LIVE FOREVER
NATURAL WONDERS
BATTLEFIELD MEDICINE STAR FACTORIES ALL ABOUT HELIUM SAVING THE SUEZ CANAL

ANNUAL PRINT
SAVE 50%

ANNUAL BUNDLE
SAVE 60%

ANNUAL DIGITAL
SAVE 45%

HOW IT WORKS | Subscription offer

FREE 2 eBOOKS 2 POSTERS & WALLPAPERS
INSIDE A SKI CAR
HOW IT WORKS
COULD WE BUILD JURASSIC PARK?
NATURAL WONDERS
HOW THE MOST SENSATIONAL SIGHTS ON PLANET EARTH CAME INTO EXISTENCE
WHY DO WE LOVE CATS?
BATTLEFIELD MEDICINE STAR FACTORIES ALL ABOUT HELIUM

WHY SUBSCRIBE?

- Brilliant value – save money on the cover price
- You'll never miss an issue
- Delivery direct to you

SUBSCRIBE NOW

www.magazinesdirect.com/hiw/knowdps

or call 0330 333 1113 and quote 97AU

£33.80 every 12 months

13 issues of **How It Works** in print over 12 months, saving 50%

£47.50 every 12 months

13 issues of **How It Works** in print and digital over 12 months, saving 60%

£28.50 every 12 months

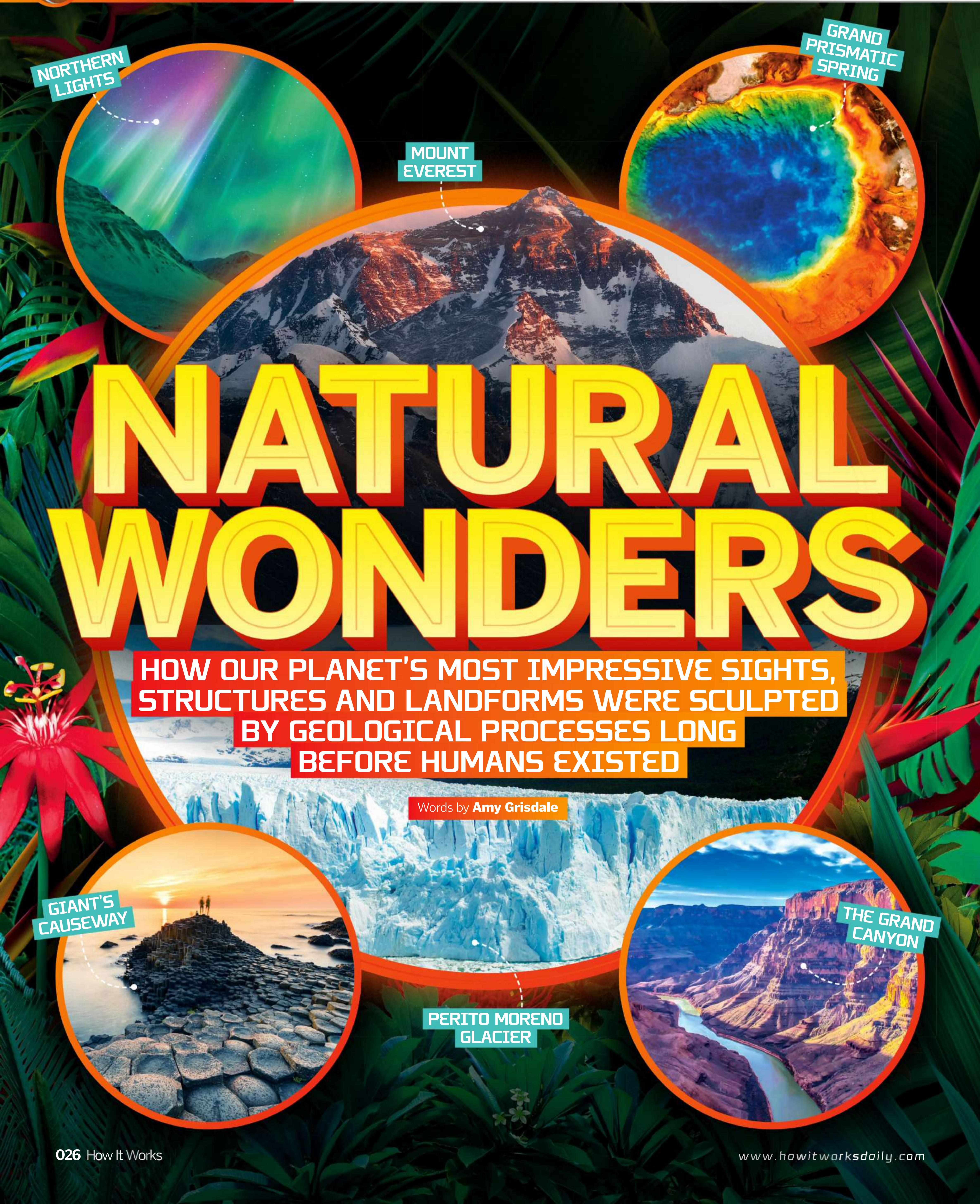
13 issues of **How It Works** in digital, saving 45%

*Terms and conditions: Offer closes 30 June 2021. Offer open to new UK subscribers only. Pricing is guaranteed for the first 12 months and we will notify you in advance of any price changes. Please allow up to six weeks for delivery of your first subscription issue, or up to eight weeks overseas. The full subscription rate is for 12 months (13 issues) and includes postage and packaging. If the magazine ordered changes frequency per annum, we will honour the number of issues paid for, not the term of the subscription. For full terms and conditions, visit **www.magazinesdirect.com/terms**. For enquiries please call: +44 (0) 330 333 1113. Lines are open Monday to Friday 9am to 5pm UK time or e-mail: **help@magazinesdirect.com**. Calls to 0330 numbers will be charged at no more than a national landline call, and may be included in your phone provider's call bundle.

NATURAL WONDERS

HOW OUR PLANET'S MOST IMPRESSIVE SIGHTS, STRUCTURES AND LANDFORMS WERE SCULPTED BY GEOLOGICAL PROCESSES LONG BEFORE HUMANS EXISTED

Words by **Amy Grisdale**


NORTHERN LIGHTS
MOUNT EVEREST
GRAND PRISMATIC SPRING
GIANT'S CAUSEWAY
PERITO MORENO GLACIER
THE GRAND CANYON

DID YOU KNOW? *Of the 1,000 caves in the Grand Canyon, only 335 have been explored, and just one is open to the public*

Aurora borealis

AGE OF WONDER
FIRST RECORDED 567 BCE

LOCATION: ARCTIC

Seeing the northern lights is at the top of most people's bucket list, and that's no surprise. It's an indescribable experience that only a lucky few will have the chance to witness in person. The phenomenon is only visible at latitudes between 60 and 75 degrees north. In the polar north it doesn't get dark enough for the lights to be seen throughout summer. Those that wish to see the spectacle must face the harsh Arctic winter. To get the best view you should seek out somewhere with very little artificial light, so head away from any settlements.

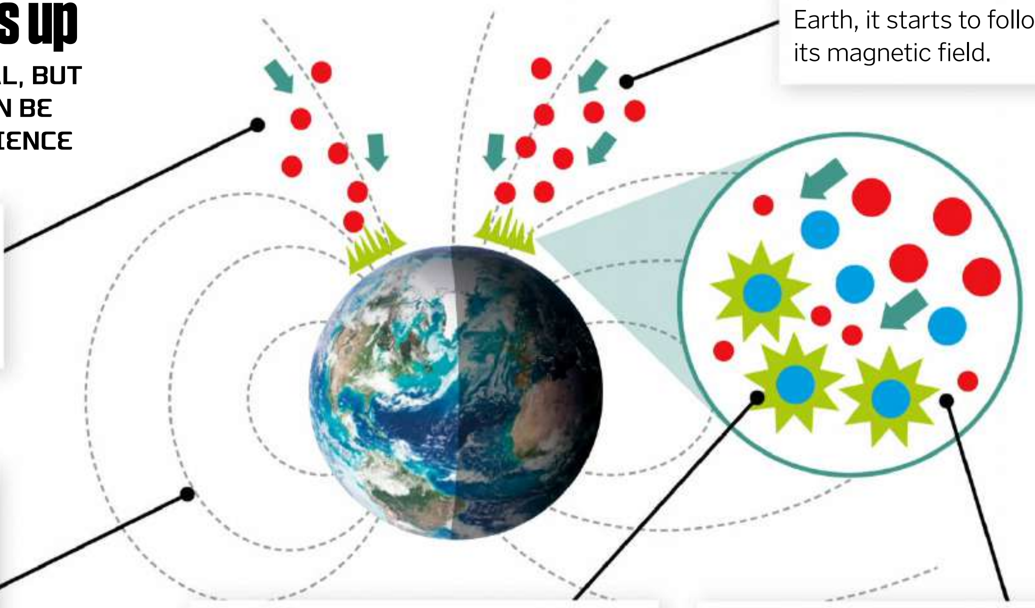
The Sun goes through an 11-year cycle. Throughout this cycle the Sun's power fluctuates, and it's when the Sun is at its most active that the northern lights are easiest to see. Travellers hoping to catch a glimpse should avoid periods where the solar activity is at its minimum. The colours will be stronger when the Sun's radiation is at its peak. We see them as mostly green because our eyes are best adapted to see green, though there can be red, pink, purple or white in the mix too.

At the opposite pole you can see the aurora australis, also known as the southern lights

© Getty

How the sky lights up

THEY MIGHT SEEM MAGICAL, BUT THE NORTHERN LIGHTS CAN BE EXPLAINED BY SIMPLE SCIENCE



Earth arrival
When particle-laden space wind reaches Earth, it starts to follow its magnetic field.

Solar wind
Protons and electrons get picked up by wind coming from the surface of the Sun.

Magnetic path
The illuminated ions can form arcs, spirals and blankets of light covering the entire sky.

Colour palette
Different gases in Earth's atmosphere produce different colours. The green is attributed to oxygen, while blue, pink and purple are caused by nitrogen.

Energy release
The atoms in the solar wind collide with particles in Earth's atmosphere, causing them to emit energy in the form of light.

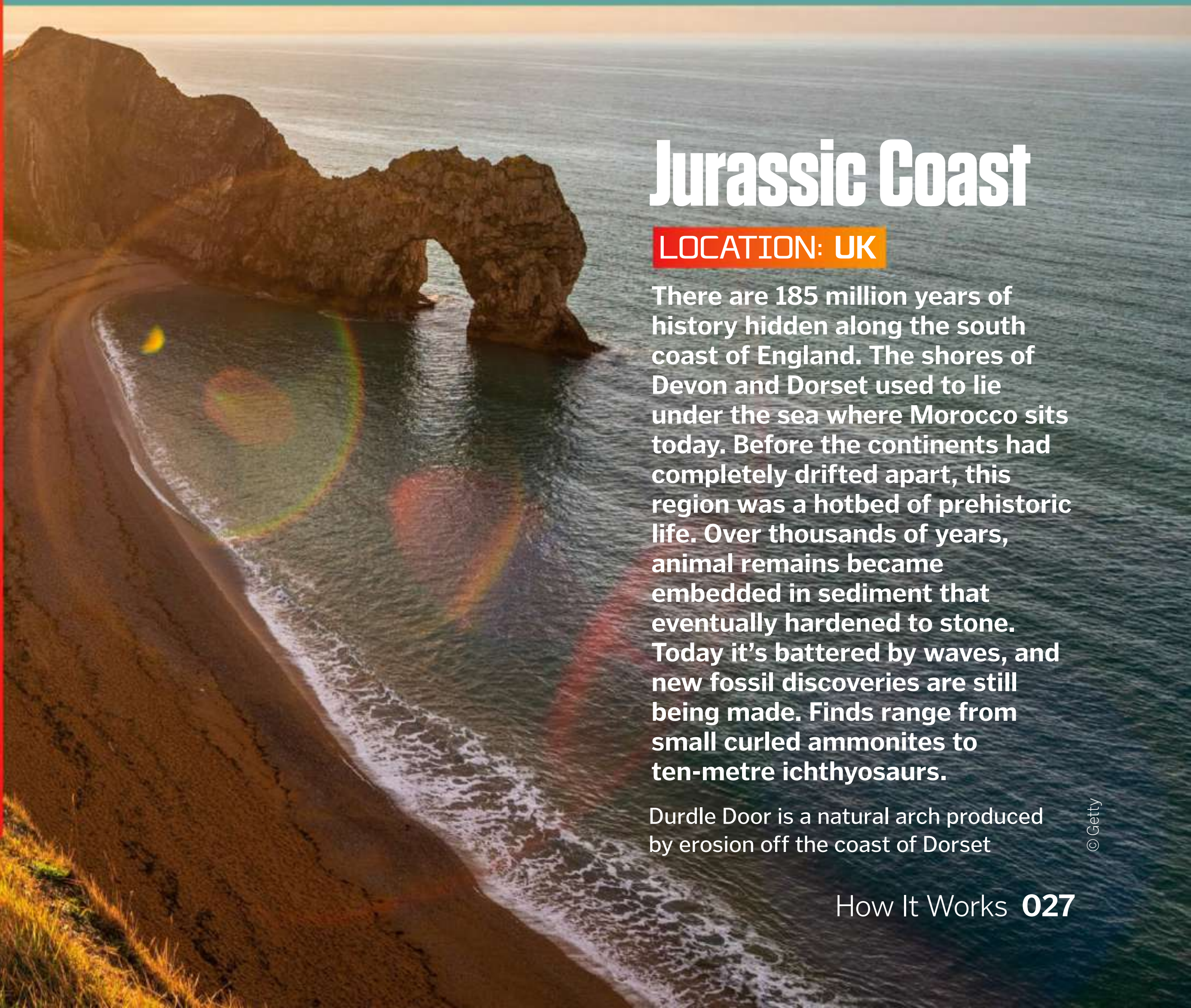
Lake Hillier

LOCATION: AUSTRALIA

Scientists are yet to figure out exactly why this Australian lake is bright pink. At the moment we think it's something to do with a species of microscopic algae called *Dunaliella salina*, which has adapted to live in extremely salty environments. They reckon the pink colour comes from a carotenoid pigment called beta-carotene that the algae produces. Other species of red bacteria also grow in the lake, but we still don't understand if they contribute to the colour.

People once tried to mine pink salt from Lake Hillier, but found their product too toxic to consume

© Getty



Jurassic Coast

LOCATION: UK

There are 185 million years of history hidden along the south coast of England. The shores of Devon and Dorset used to lie under the sea where Morocco sits today. Before the continents had completely drifted apart, this region was a hotbed of prehistoric life. Over thousands of years, animal remains became embedded in sediment that eventually hardened to stone. Today it's battered by waves, and new fossil discoveries are still being made. Finds range from small curled ammonites to ten-metre ichthyosaurs.

Durdle Door is a natural arch produced by erosion off the coast of Dorset

© Getty

Komodo island

LOCATION: INDONESIA

Famous for its giant lizards, this volcanic island in southern Indonesia is part of the Lesser Sunda Islands. The Komodo dragons themselves are the island's big draw. They're the largest living lizards, and they're descendants of the biggest lizards known to science. With no predators on the island they were able to grow even larger. Eventually most of the native prey disappeared, and they now eat animals that have been introduced to the island, from rats to water buffalo.

© Getty

Komodo has never been connected to the mainland, and is home to unique species

Valley of Geysers

LOCATION: RUSSIA

With 22 active geysers and another 20 lying dormant, this 3.7-mile basin in eastern Russia is the second most concentrated area of geysers worldwide. The water never drops below 19 degrees Celsius, and the valley is filled with sulphurous steam. Some of the geysers go up every ten minutes or so, while others take hours to build. The surrounding soil is now clay after thousands of years of exposure to heat and sulphuric acid.

© Getty

The Kamchatka Peninsula houses 19 active volcanoes alongside its impressive geysers

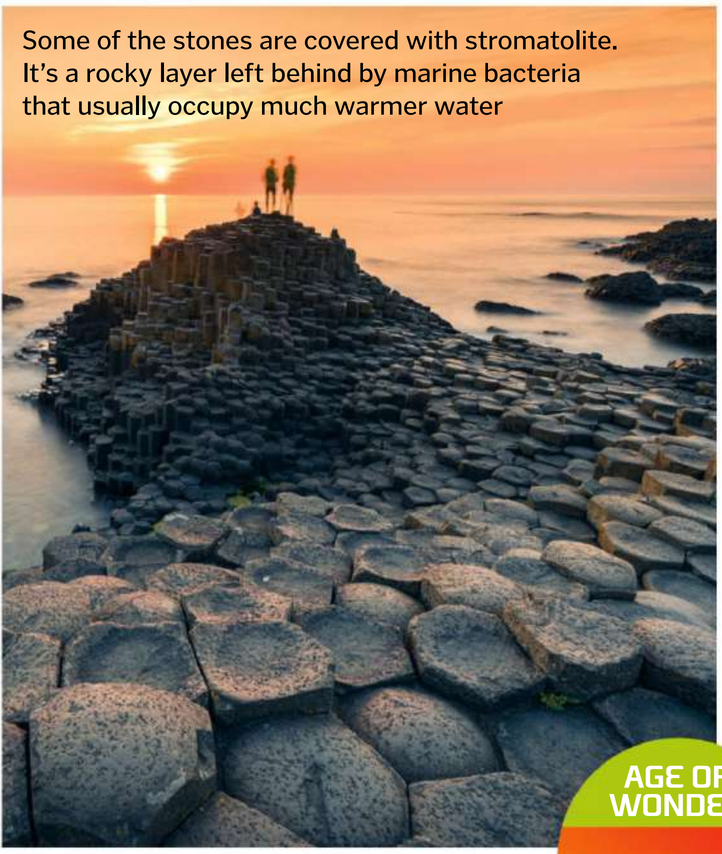
After sunset, lightning strikes an average of 28 times a minute. This can go on for nine consecutive hours

© Alamy

Lake Maracaibo

LOCATION: VENEZUELA

This tidal bay gets more lightning strikes than anywhere else on Earth. There are storms 260 days of the year. The lake sits on top of one of the most oil-rich places remaining today. Winds from the Andes Mountains collide with an area of low pressure, and the surrounding bog releases decomposing methane from the buried oil. It's lighter than air, and therefore rises. It collides with the wind, and all that heat, moisture and the charged methane particles whirl together to create massive electrical activity.



Some of the stones are covered with stromatolite. It's a rocky layer left behind by marine bacteria that usually occupy much warmer water

© Getty

AGE OF WONDER

50-60 MILLION YEARS

Giant's Causeway

LOCATION: NORTHERN IRELAND

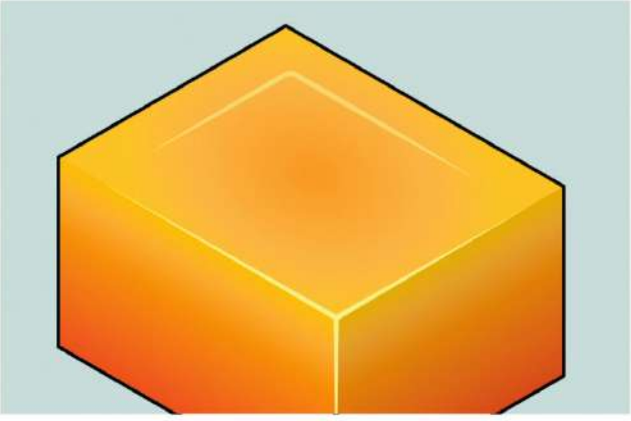
There are 40,000 'stepping stones' in this landform, some of which stand at almost 12 metres tall. It gets its name from the legend that a giant named Fionn mac Cumhaill (Finn MacCool) built it to walk across to fight an enemy giant in Scotland.

The basalt rocks interlock so perfectly that at first glance the whole thing appears to be human-made. But each stone is uniquely shaped and has a different number of sides. Some are octagonal, others are square and a few are almost round. The adjacent cliffs are made of the same volcanic rock that's 28 metres thick.

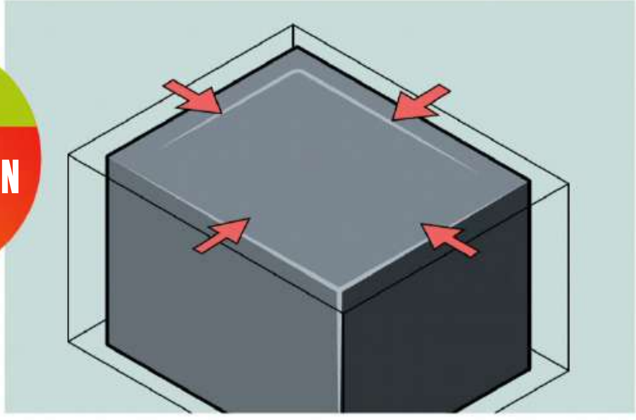
After being exposed to the elements for millions of years, erosion has sculpted the surrounding rocks. Visitors can see boulders shaped like a boot and an organ, as well as the tall 'chimney stacks' displaced by the weight of the massive basalt columns.

Causeway construction

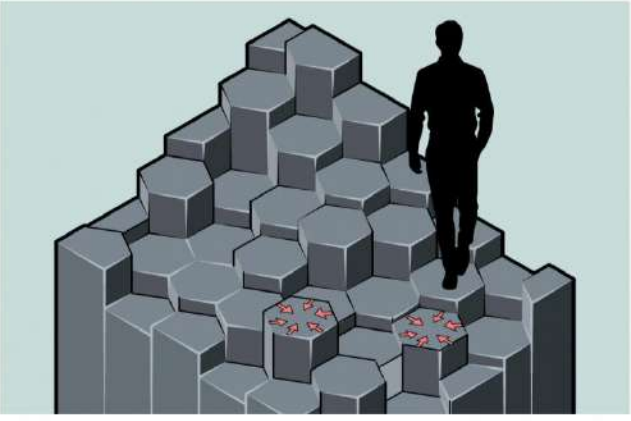
EARTH MANAGED TO MAKE THIS BEAUTIFUL FEATURE COMPLETELY BY ACCIDENT



1 Red-hot rock Millions of years ago, bubbling lava spurted up through the ground and created a lake of lava.



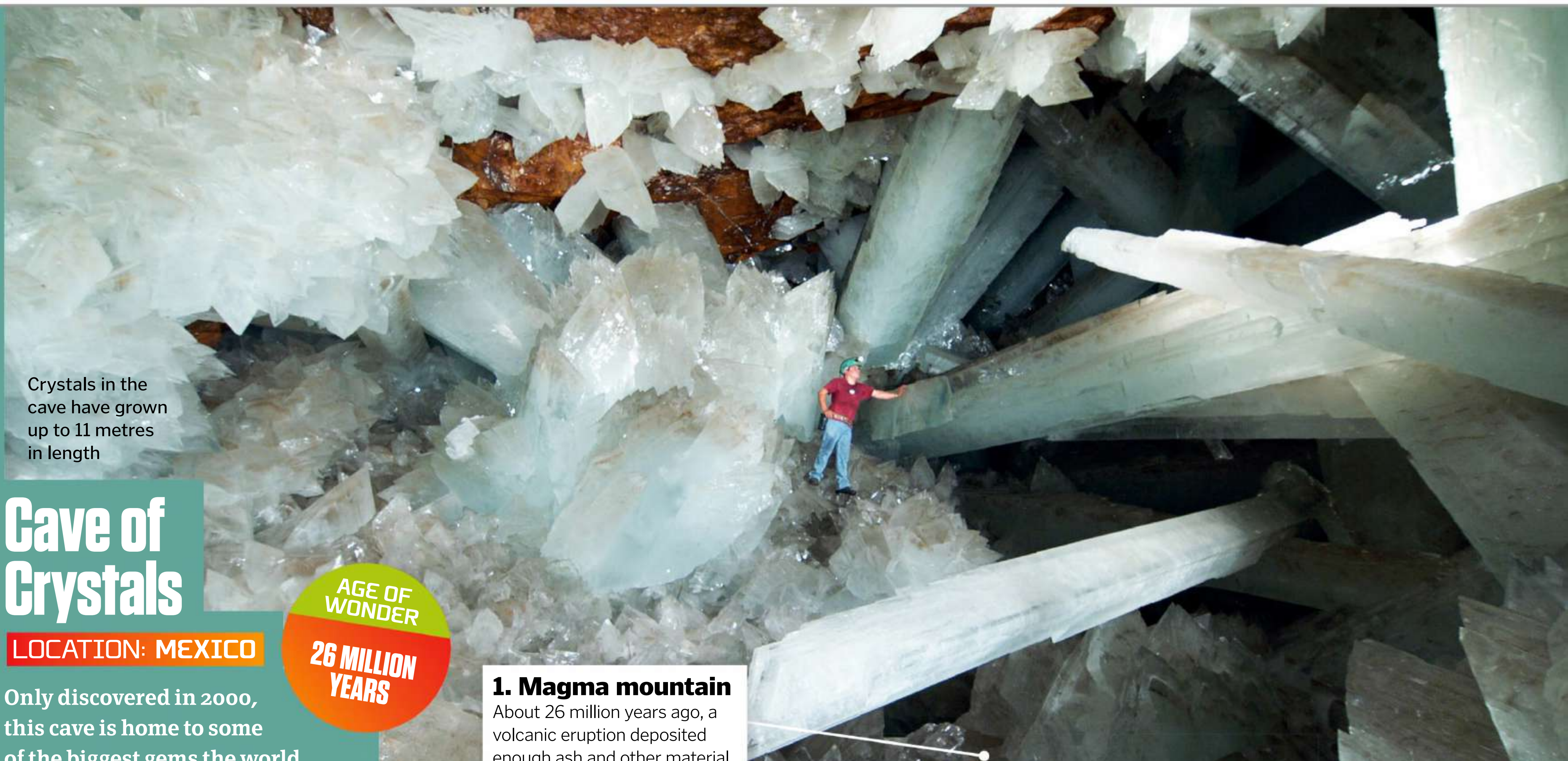
2 Rapid cooling What was once liquid magma cooled down and solidified. It didn't form a single, solid sheet (shown in the illo above) but cracked into hexagonal columns.



3 Making space The individual pieces shrank away from each other and eroded after the volcanic rock split, giving it the appearance of a paved walkway.

© Illustration by Ed Crooks

DID YOU KNOW? *Examining Sahara sand reveals the desert transforms into a lush oasis and back every 20,000 years*



Source: Wiki/Alexander Van Driessche

Crystals in the cave have grown up to 11 metres in length

Cave of Crystals

LOCATION: MEXICO

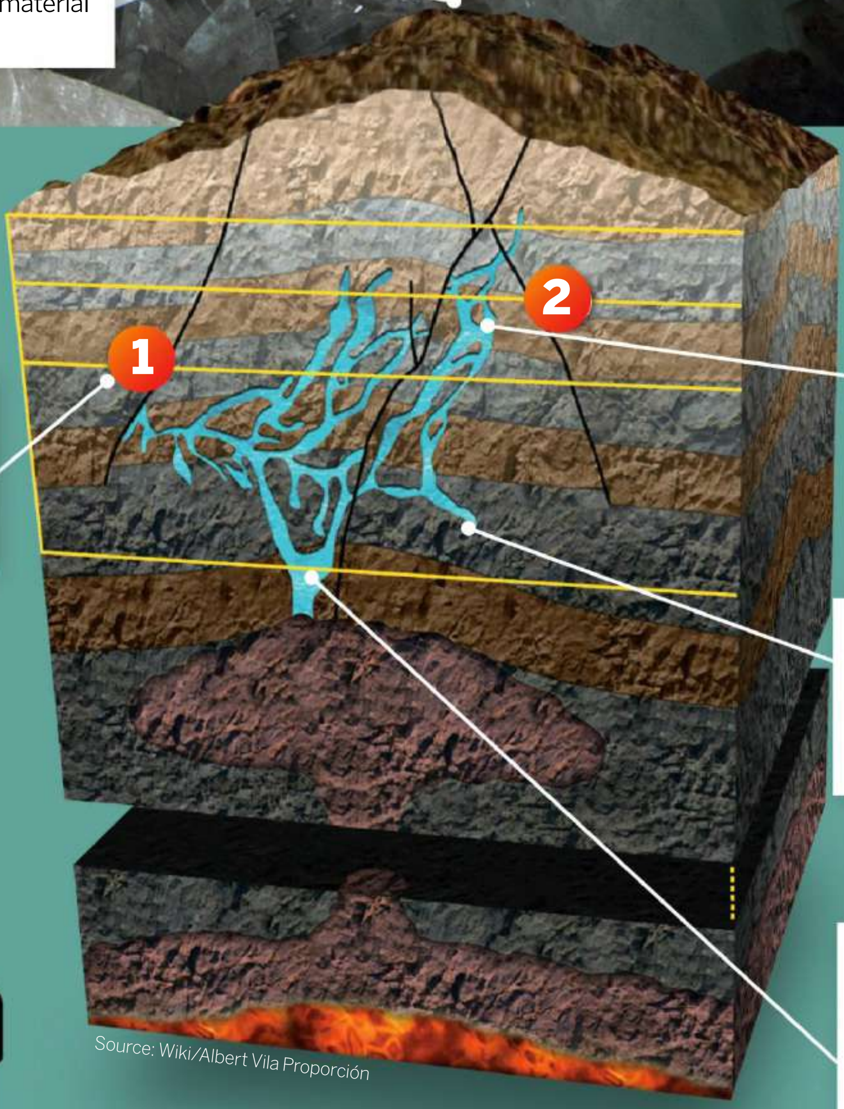
AGE OF WONDER
26 MILLION YEARS

Only discovered in 2000, this cave is home to some of the biggest gems the world has ever seen. They're also unique because of their milky-white colour – gypsum crystals like this are usually transparent. They were made underwater by a process called nucleation, which caused tiny particles to interact and settle in just the right arrangement. The temperature, salt content and dissolved minerals in the surrounding water all helped with the crystals' formation.

A flurry of mining activity led to the discovery of the Cave of Swords in 1910 – another chamber in the same system. Over years of human interference, water was slowly drained from the lower cave, revealing the massive crystals. Since then, fragile 'sails' have formed on the tips of the crystals. Warm air rises up and pushes a thin layer of crystal up and away from the surface.

Growing giant gems

THE CAVE SPROUTED CRYSTALS WHEN EXPOSED TO EXTREME ENVIRONMENTAL CHANGES



Source: Wiki/Albert Vila Proporción

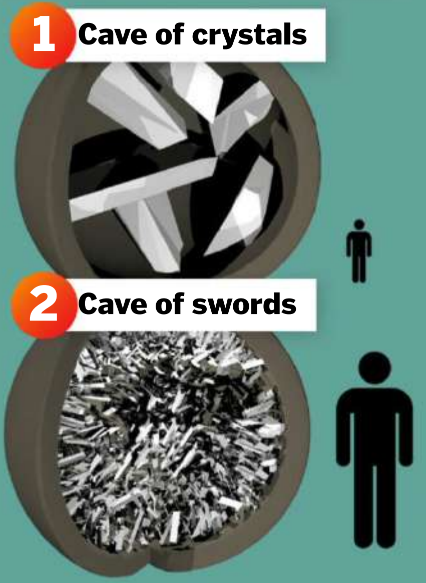
1. Magma mountain About 26 million years ago, a volcanic eruption deposited enough ash and other material to create a mountain.

2. Flooding The volcano forced hot water full of minerals into caverns and crevices in the newly formed rock.

3. Element buildup Calcium and sulphate in the trapped water reacted, depositing crystals of anhydrite throughout the cave system.

4. Out with the old As time marched forward the water cooled and the anhydrite became less stable, beginning to dissolve.

5. In with the new An influx of calcium and sulphate from the melting crystals created ideal conditions for enormous gypsum crystals to develop.



Ha Long Bay

LOCATION: VIETNAM

Nestled in the Gulf of Tonkin in northeast Vietnam, there are 1,600 islands dotted throughout this 580 square mile bay. A layer of limestone developed over 500 million years, and by the end of the Permian Period it was 1,000 metres thick. The hunk of rock was weathered by the sea since then, but really took a beating in the last ice age. The slab broke apart, and the fragments are the islands we see today.

Many people live in floating fishing villages rather than disturbing the pristine islands

© Getty

Perito Moreno Glacier

LOCATION: ARGENTINA

While most of them are melting, this huge glacier has barely changed in the last 50 years. It crawled forward at least 800 metres in the 1800s and may still be advancing today. It accumulates more mass than any other glacier currently being monitored. The rocks that the glacier is bonded most strongly to are called pinning points. Glaciers usually retreat when they lose these pinning points, but Perito Moreno is holding firm.

© Getty

This is a calving glacier, meaning it breaks off piece by piece where it hits the water

© Getty

Zhangjiajie National Forest Park was the inspiration for the landscape of Pandora in the 2009 film *Avatar*

Zhangjiajie

LOCATION: CHINA

This stunning Chinese forest's unique features are its 3,000 tall, thin pillars made of quartz and sandstone. Many stand over 200 metres tall while the tallest reaches 1,080 metres. The pillars came about from physical weathering. Water seeped into cracks in the rocks and expanded, breaking the ground apart. Deep tree roots snaking deep into the fractured Earth only sped up the process of wearing away the bedrock below.

Great Barrier Reef

LOCATION: AUSTRALIA

Almost 3,000 individual reefs make up the biggest coral system in the world, lying off the coast of Queensland. It's home to more than 1,500 species of fish, a third of the world's soft coral and six of the seven species of sea turtle.

Sadly, the Great Barrier Reef has lost half its coral since 1985. The damage is happening so fast that we're falling behind on assessing it. Corals have died off because of pollution, invasive species and a process called bleaching. Water is simply getting too warm for corals to survive.

© Getty

The reef is the largest living thing on Earth and can be seen from space

Sahara Desert

LOCATION: AFRICA

AGE OF WONDER
2.5 MILLION YEARS

One of the biggest deserts on Earth spans 11 countries. It touches the Atlantic Ocean on the west and the Red Sea to the east. Scientists agree that the region existed millions of years ago as a green paradise, but there's a lot of disagreement about how and when the desert itself started forming.

Earth isn't a perfect sphere – it doesn't have an even distribution. It's wider than it is tall, and that causes a bit of instability in its orbit. When our planet rotates, it can wobble on its axis, and those shifts can see it change its orbit ever so slightly. The times when Earth crept closer to the Sun coincide with the periods the Sahara went through extreme drought. We still aren't sure if it dried out all in one go or if it went back and forth between green and sandy over time.

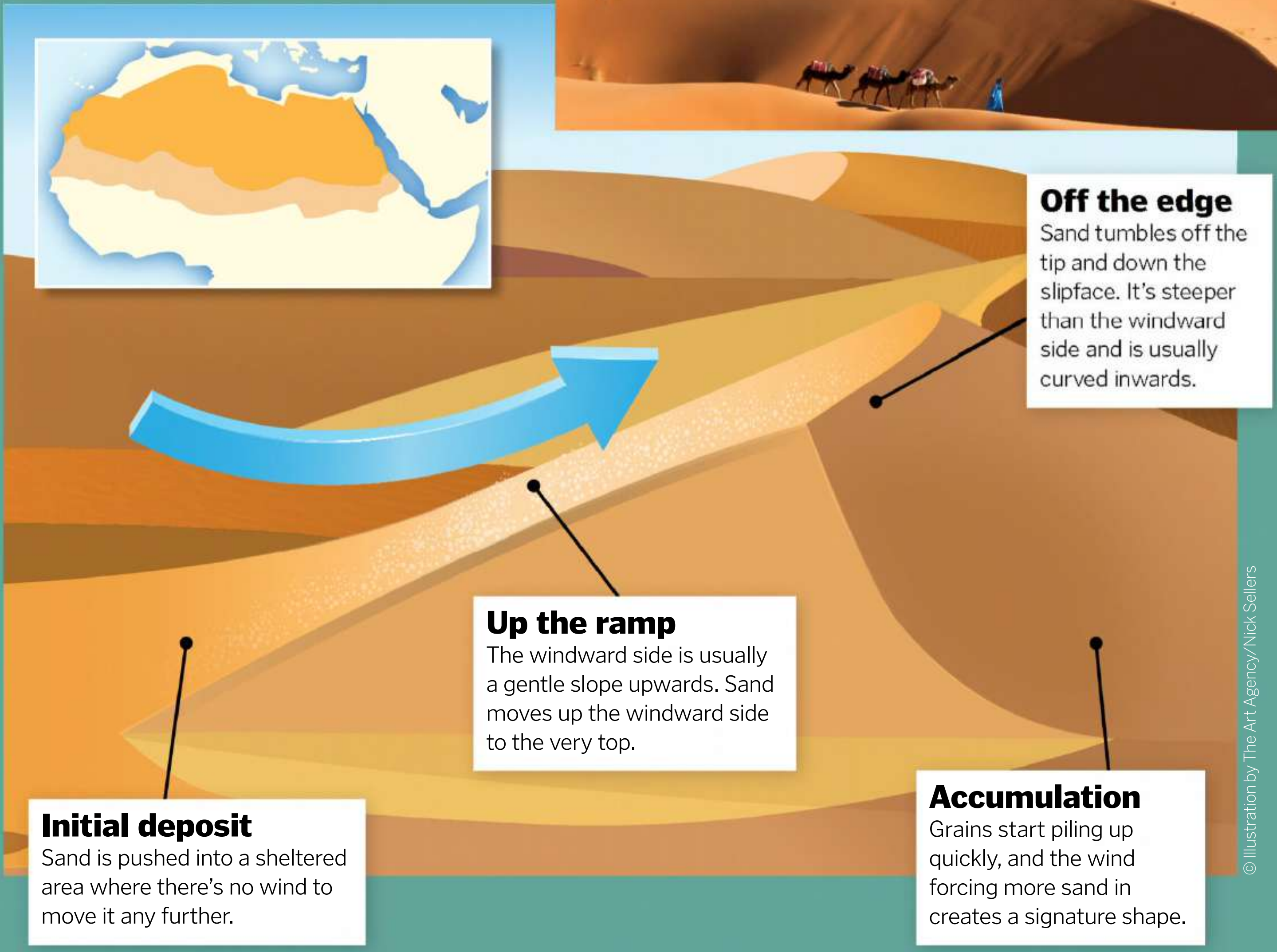
Two permanent rivers flow through the Sahara: the Nile and the Niger. Around 20 lakes appear seasonally, feeding almost 100 major watering holes. Summer temperatures can reach 47 degrees Celsius. Even though conditions are harsh, it's home to lots of wildlife. Hyenas, gazelles and baboons roam the region along with more famous desert species like camels and sand foxes.

The average night temperature of the Sahara is minus four degrees Celsius

© Getty

How the wind sculpts sand

DESERT BREEZES CREATE LANDFORMS FROM THE SAND AS THEY BLOW



Off the edge
Sand tumbles off the tip and down the slipface. It's steeper than the windward side and is usually curved inwards.

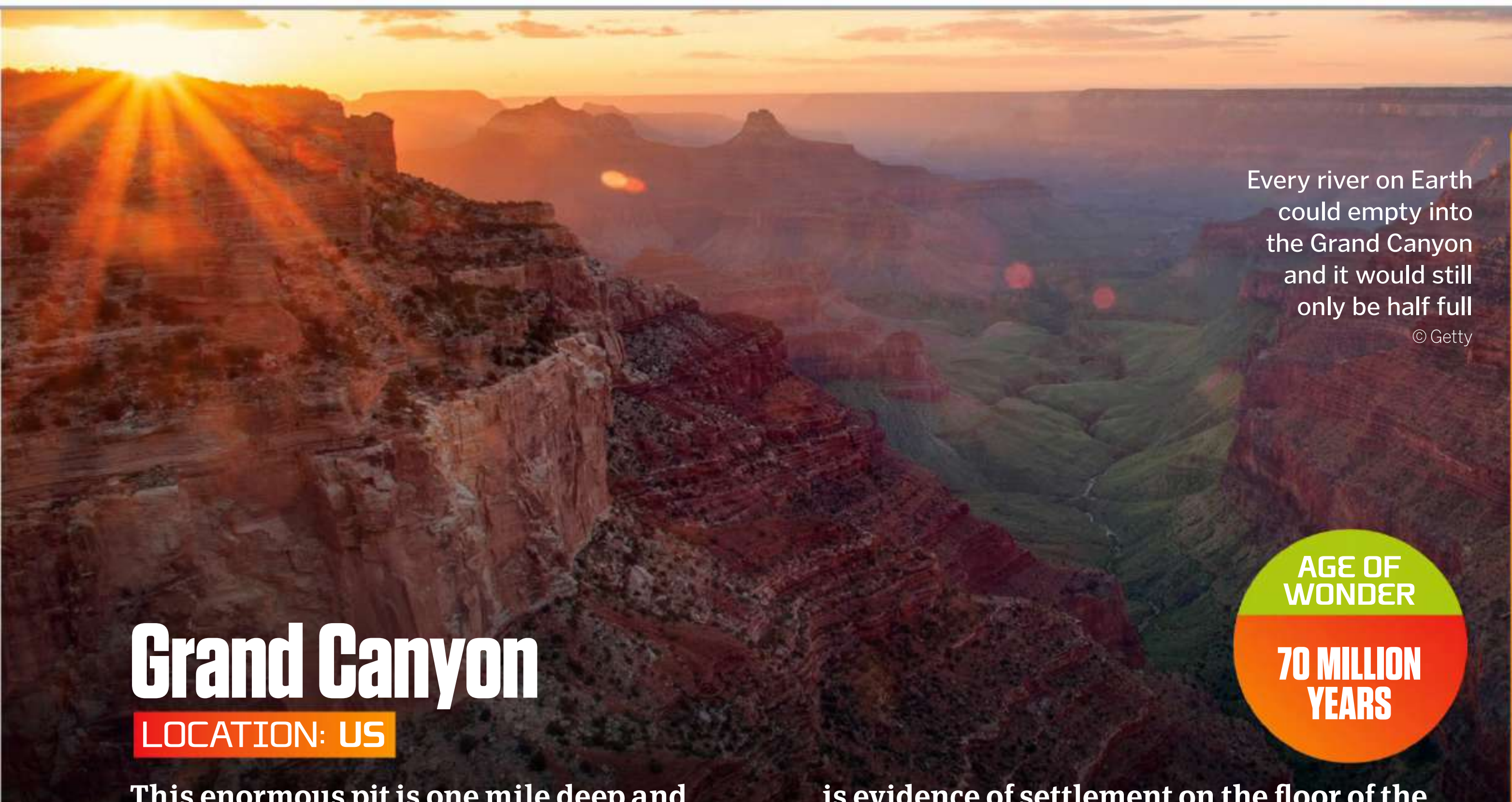
Up the ramp
The windward side is usually a gentle slope upwards. Sand moves up the windward side to the very top.

Initial deposit
Sand is pushed into a sheltered area where there's no wind to move it any further.

Accumulation
Grains start piling up quickly, and the wind forcing more sand in creates a signature shape.

© Illustration by The Art Agency/Nick Sellers

DID YOU KNOW? *Glaciers leave telltale geology behind long after melting, like long, thin lakes and U-shaped valleys*



Every river on Earth could empty into the Grand Canyon and it would still only be half full

© Getty

AGE OF WONDER

70 MILLION YEARS

Grand Canyon

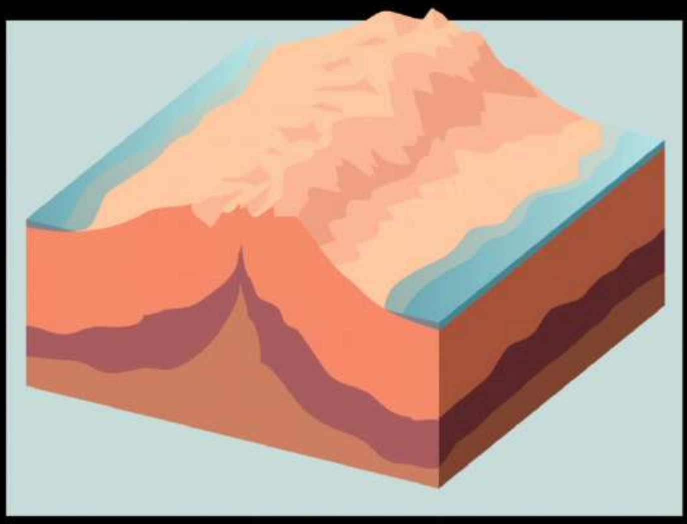
LOCATION: US

This enormous pit is one mile deep and stretches for 277 miles, covering more area than Rhode Island. It's so big it impacts the local weather; its depth affects the Sun's heat and how air circulates, creating a load of different microclimates. The Grand Canyon has the wettest, driest, warmest and coldest weather stations in the entire region.

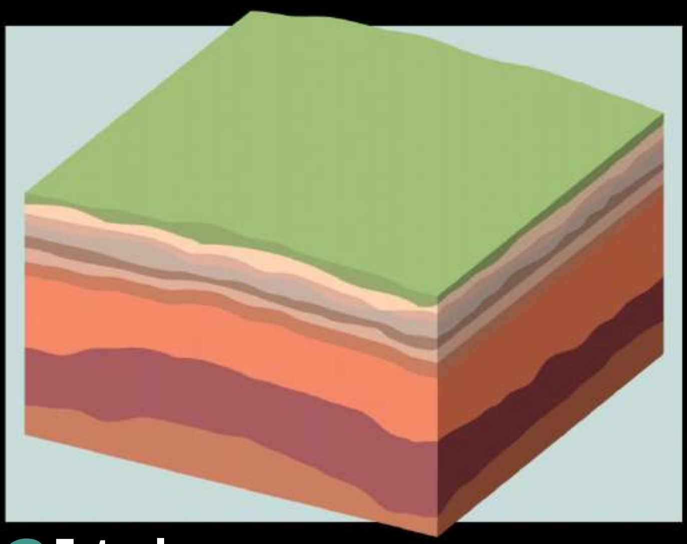
At least 11 Native American tribes live in and around the canyon to this day, and there is evidence of settlement on the floor of the Grand Canyon going back 10,000 years. We know people hunted Nothrotheriops, an extinct species of giant sloth, made twig figures and planted crops. It was only established as a National Park in 1919, and most Americans didn't even know it existed before a famous Civil War veteran wrote about his travels there in 1869. Today roughly 6 million people visit the canyon each year.

Grand excavation

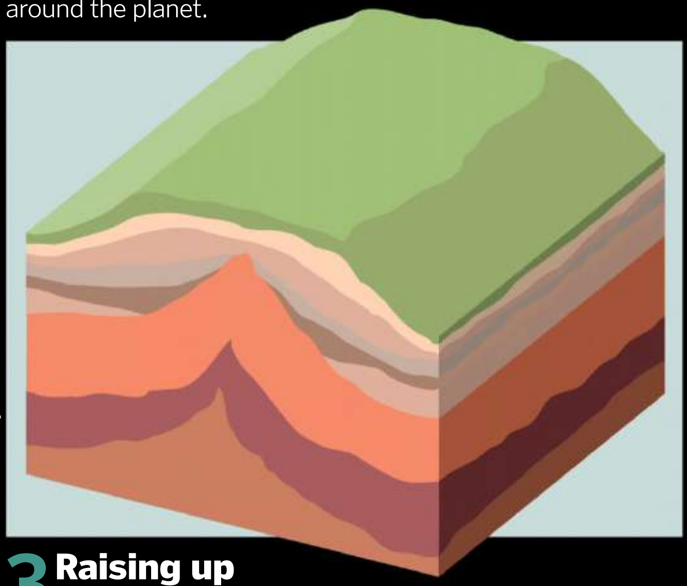
THE GEOLOGICAL ACTION THAT LED TO THE CREATION OF THE GRAND CANYON STARTED LONG BEFORE THE FIRST DINOSAURS EVOLVED



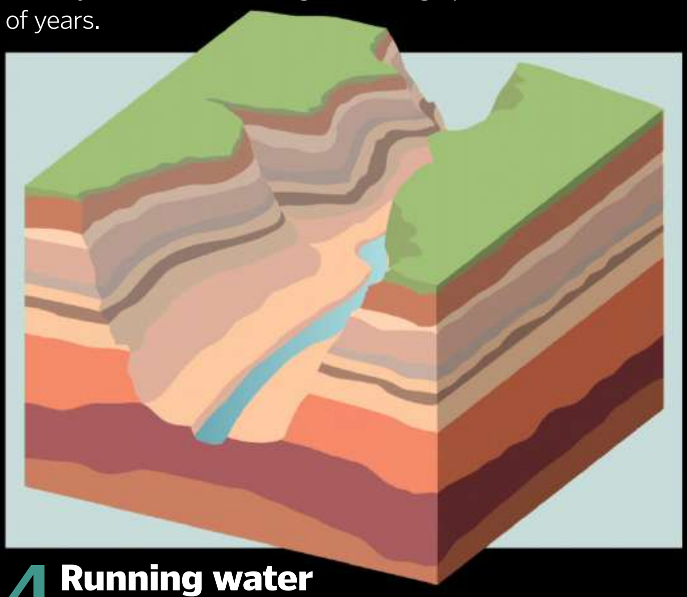
1 Smashing plates
Almost 2 billion years ago, two rows of volcanic islands crashed into one another as the continents were shifting around the planet.



2 Extra layers
The tops of the mountains were levelled by erosion, and new layers of sediment began building up over thousands of years.



3 Raising up
Tectonic plates pushed the flat plateau upwards and began to rupture the uppermost layers of rock.



4 Running water
The changing landscape diverted the Colorado River, which quickly cut a course through the many layers of rock, leaving the canyon we see today.

© Illustration by Ed Crooks

Parícutin

LOCATION: MEXICO

This is one of Earth's youngest volcanoes that suddenly emerged in a field. Its first recorded eruption was on 20 February 1943. The torrent of fire and lava destroyed two villages. Their only warning had been some rumbling the week prior. In the first year of its life it grew 450 metres. Eruptions continued for the next nine years, finally coming to a halt in 1952. By then the volcano stood at 2,808 metres.

© Getty

Nobody died in the decade-long eruption, but three people were killed by lightning strikes generated by volcanic activity

Peyto Lake

LOCATION: CANADA

This gorgeous lake is in Banff National Park, the oldest in Canada. Peyto Lake is fed by active glaciers. The flowing glaciers scrape away fragments of rock as they advance. Where the ice contacts the rock is wet and slippery, allowing water to wash the bits of rock down to sea level under the frozen river. This rock reflects blue light, and our eyes see it as a vivid turquoise. This effect is strongest in the summer when glaciers melt the fastest.

© Getty

Because Banff National Park has a protected status, it's against the law to pick a single flower within its boundaries

AGE OF WONDER

60 MILLION YEARS

Mount Everest

LOCATION: NEPAL AND CHINA

The planet's biggest mountain is so tall that climbers need special equipment to survive a trip to the top. The wind up there can reach 200 miles per hour, and there is barely enough oxygen in the air to survive. At least 304 people have died on the mountain since 1924, but it's too dangerous to retrieve most of the bodies, and so they remain frozen to the hillside. Some are recognisable by their clothing and have been given nicknames by passing climbers.

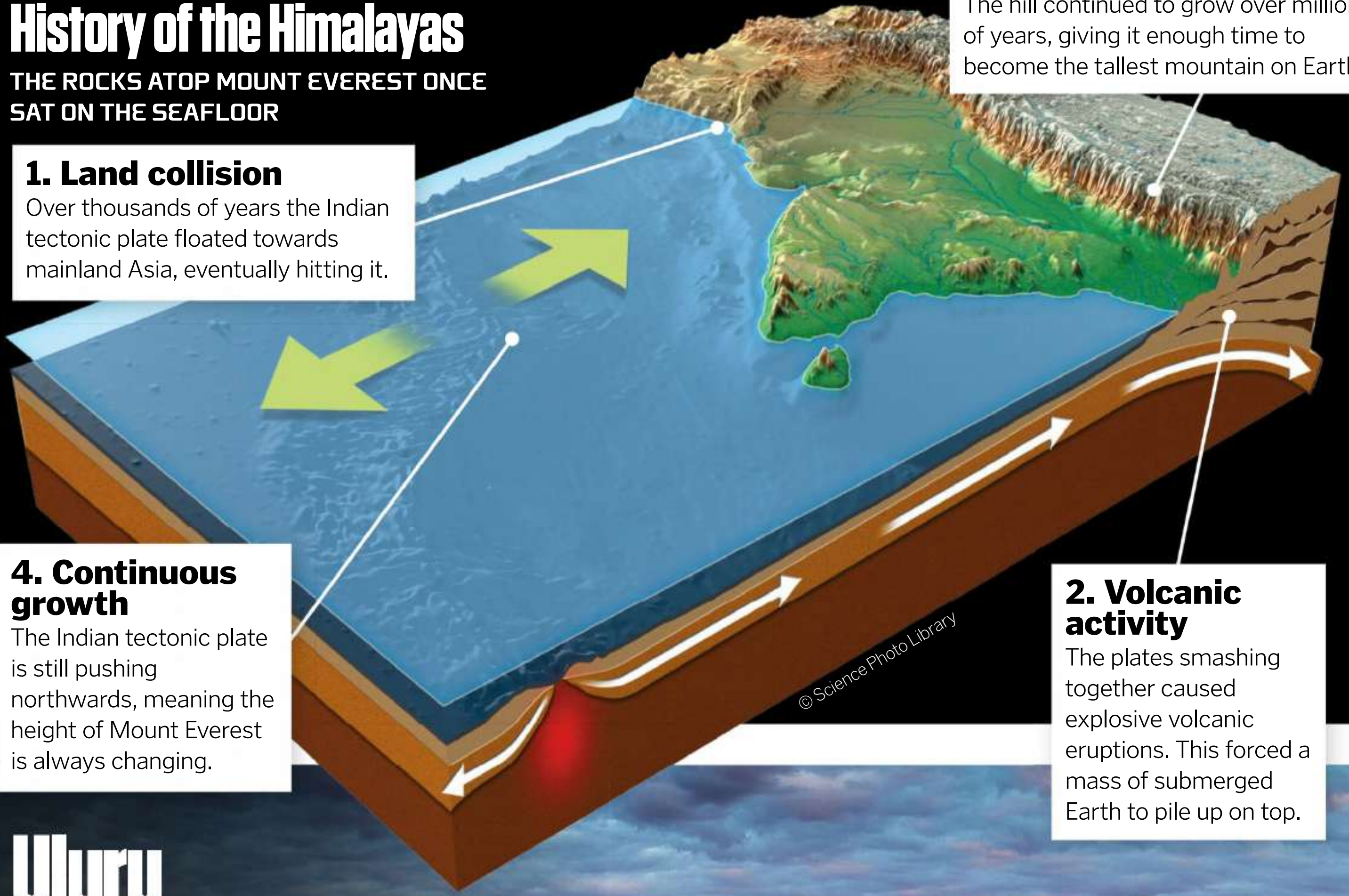
The mountain wasn't conquered until 1953, but is now on many people's bucket lists. There are around 18 routes to the top and a typical climb takes 40 days. Visitors are usually assisted by Sherpas, the people of Western Nepal. The Himalayas hold special significance to them and they have the skills and equipment needed to climb Everest over and over again.

Climbing Everest takes a toll on the body, and most explorers lose between five and nine kilograms

© Getty

History of the Himalayas

THE ROCKS ATOP MOUNT EVEREST ONCE SAT ON THE SEAFLOOR



1. Land collision
Over thousands of years the Indian tectonic plate floated towards mainland Asia, eventually hitting it.

2. Volcanic activity
The plates smashing together caused explosive volcanic eruptions. This forced a mass of submerged Earth to pile up on top.

3. Immature mountain
The hill continued to grow over millions of years, giving it enough time to become the tallest mountain on Earth.

4. Continuous growth
The Indian tectonic plate is still pushing northwards, meaning the height of Mount Everest is always changing.

© Science Photo Library

Uluru

LOCATION: AUSTRALIA

This Australian landform is known as an inselberg, which means 'island mountain'. Rainwater flowing from the surrounding mountains wore parts of the rock away 550 million years ago. The area then flooded completely, and the eroded rock hardened under the weight of the sea. After being submerged for 100 million years, tectonic plate movements diverted water away. The hardened boulder stood strong while the weak stone crumbled, leaving the 348-metre-tall hunk of rock we see today.

Most of this boulder is underground. It's like an iceberg – we can only see the tip

© Alamy

Victoria Falls

LOCATION: AFRICA

Africa is home to one of the world's most famous waterfalls. Its one mile width is remarkable. The bedrock beneath the Zambezi River is volcanic rock that formed 180 million years ago. Lava cooled and cracked in several places from east to west. The splitting of the supercontinent Gondwana widened the cracks as tectonic plates pushed southern Africa upwards. This caused an enormous lake to spill over and erode a new course to the sea. The water now sails elegantly off the cliffs of the fractured volcanic rock.

© Getty

The far edges of the falls are most at risk of erosion and may narrow in the future

Pamukkale

LOCATION: TURKEY

Hot water from the ground flows from a clifftop spring 200 metres from the ground in western Turkey. The water comes out so lovely and warm because it springs from 320 metres underground. As water leaves the spring it makes contact with the air for the first time and begins to change. Initially it's fully saturated with minerals, but a chemical reaction causes it to release carbon. As this process happens, it leaves a coating of crystals behind.

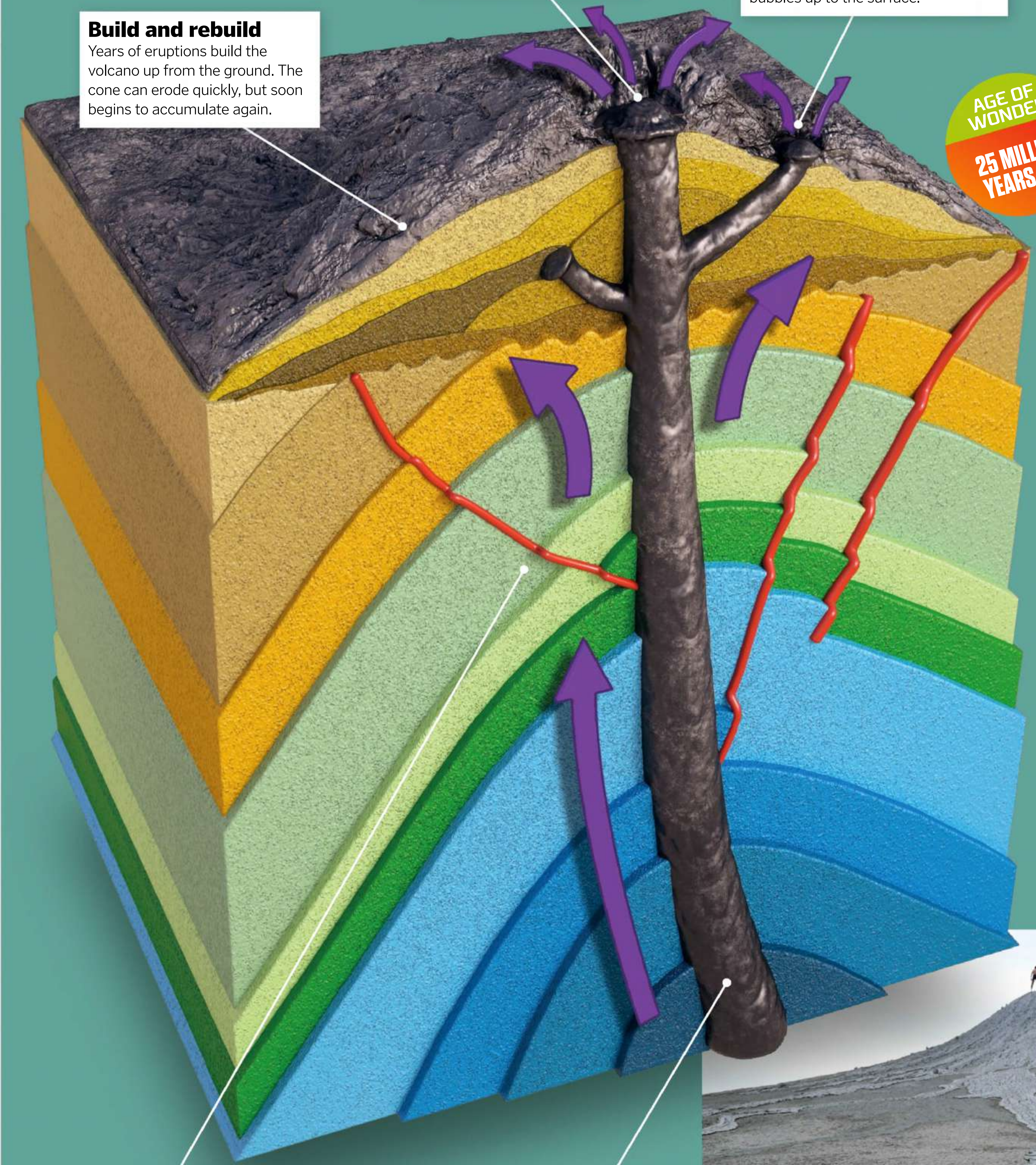
© Getty

There are ruins of a bathhouse that was built in 200 BCE, along with other ancient Greek monuments at the same site

DID YOU KNOW? *Denali in Alaska is taller than Everest measured from sea level, but Everest is a bigger mountain*

A look underground

THERE'S MORE GOING ON IN MUD VOLCANOES THAN MEETS THE EYE



Build and rebuild
Years of eruptions build the volcano up from the ground. The cone can erode quickly, but soon begins to accumulate again.

Primary crater
There is exposed mud at the summit of the volcano cone. It also comes out of secondary vents around the main crater.

Secondary salse
Thin liquid mud in a pool, rather than a cone, is called a salse. This is where methane gas from deep underground bubbles up to the surface.

Extreme force
The upward force of the dirty upwellings has been enough to shoot through layer upon layer of rock beneath the surface.

Deep trench
More often than not, the feeder channel connects to buried oil reserves. Trace amounts of oil come up with the mud.

© Illustrated by Nicholas Forder

Goturdag mud volcano

LOCATION: **AZERBAIJAN**

AGE OF WONDER
25 MILLION YEARS OLD

There are around 2,800 mud volcanoes spread across 42 countries. Some are underwater, but others are hundreds of metres above sea level. Azerbaijan is home to 353 of these mud volcanoes. The small ones bubble away quietly, while larger mud volcanoes erupt in fiery explosions, shooting mud, flames and smoke into the air. Recent eruptions have been so violent that the aftermath of one explosion could be seen from nine miles away three days later.

They're much colder than lava-filled volcanoes. Their temperature is usually pretty constant and can be anywhere from 2 to 100 degrees Celsius. They also don't grow as large as igneous volcanoes. Azerbaijan's biggest is only 700 metres high. It's far enough from civilisation to pose no threat, but there have been reports of nomadic shepherds and their flocks being struck with flying mud in the past.

NASA geologists have found the structure of Azerbaijan's mud volcanoes to be eerily similar to the uplands of Mars

© Getty

AR ZONE! SCAN HERE

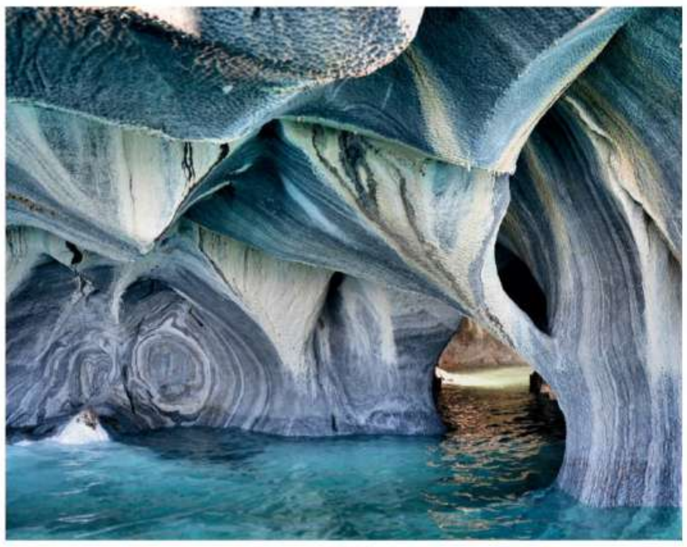
The Maldives

LOCATION: MALDIVES

This country is made up of 1,190 small islands surrounded by coral reefs. Almost 1,000 of the islands are uninhabited by humans. The shores of the Maldives are piled with soft coral sand. With an average elevation of 1.5 metres, it's both the lowest and flattest nation on Earth. If sea levels rise at the rate scientists predict, a lot of the Maldives might disappear. The lowest lying areas could be gone by 2100.

© Getty

In the 1600s Maldivians built houses and places of worship from coral, and some still stand today



© Getty

Minerals in the glacial lake react with the cave walls, dyeing them blue, green, purple and yellow

Marble Caves

LOCATION: CHILE

The glittering walls of these Chilean caverns were sculpted by the crashing waves of General Carrera Lake. The natural marble cliffs have been pounded by water, leaving an intricate system of tunnels. The lake is glacial water, so it's full of dissolved matter that was once stuck in the ice. These small particles add to the destructive effect of the water. There are also enormous hunks of top-heavy sculpted marble outside the caves that have been narrowed by erosion.

Salar de Uyuni

LOCATION: BOLIVIA

These are the biggest salt flats in the world, stretching more than 4,000 square miles and sitting at an elevation of 3,656 metres. The ground is covered by salt crust that's several metres thick. The entire plain was permanently flooded at least four times in the last 40,000 years. Cactuses are the only plants that can grow on the salt flats, but three species of flamingo come here to breed every November.

© Getty

More than 80 species of bird can be seen at Salar de Uyuni, along with chinchillas and Andean foxes

Niagara Falls

LOCATION: CANADA AND US

AGE OF WONDER
12,000 YEARS

There are at least 500 taller waterfalls, but Niagara holds the record for flow rate. It would take half a second for Niagara Falls to fill an Olympic pool. 28 million litres spill over the edge every second, even though up to three-quarters of the river is diverted for human use further upstream.

The sheer mass of water causes a huge amount of erosion. The waterfall has shifted seven miles in the last 12,000 years. That might sound slow, but geologists are pretty sure it's the fastest retreating waterfall.

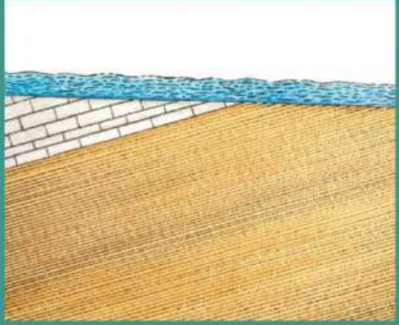
The falls have only stopped flowing once in recorded history, when chunks of ice blocked the river's path. There's a chance it could dry up again for a short time in the future if government-funded construction needs to divert the Niagara River.

© Getty

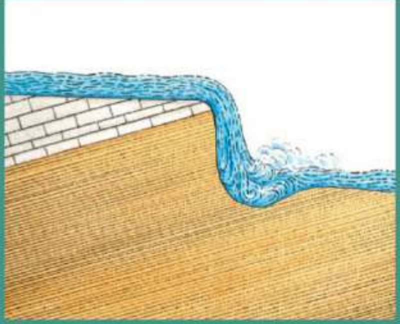
Nikola Tesla built the world's first hydroelectric power plant at Niagara Falls in 1893

How the waterfall formed

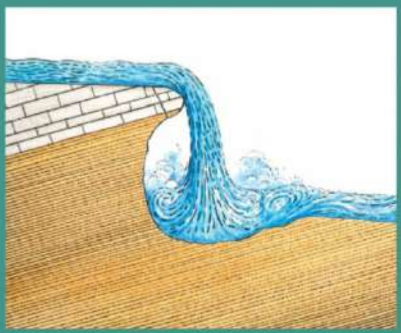
IT TAKES A LONG TIME AND THE RIGHT GEOLOGY FOR A TRICKLE TO BECOME A THUNDERING TORRENT



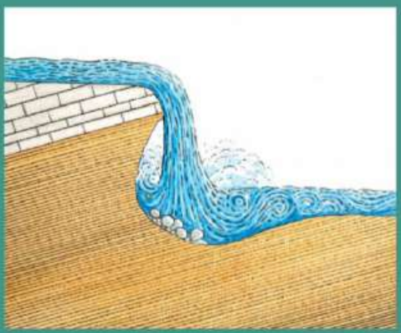
1 Ground geology Waterfalls usually begin their lives in areas where hard rock meets softer stone.



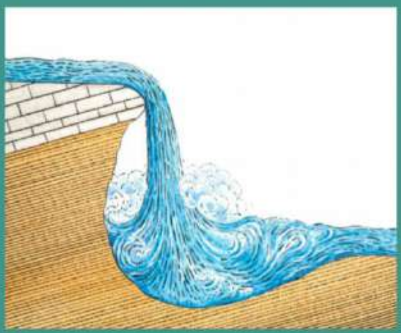
2 First step Flowing water erodes the soft rock and washes the debris downstream, leaving the water flowing down a small step.



3 Breaking point As more and more sediment is swept away, the hard rock can collapse into the shallow pool below.



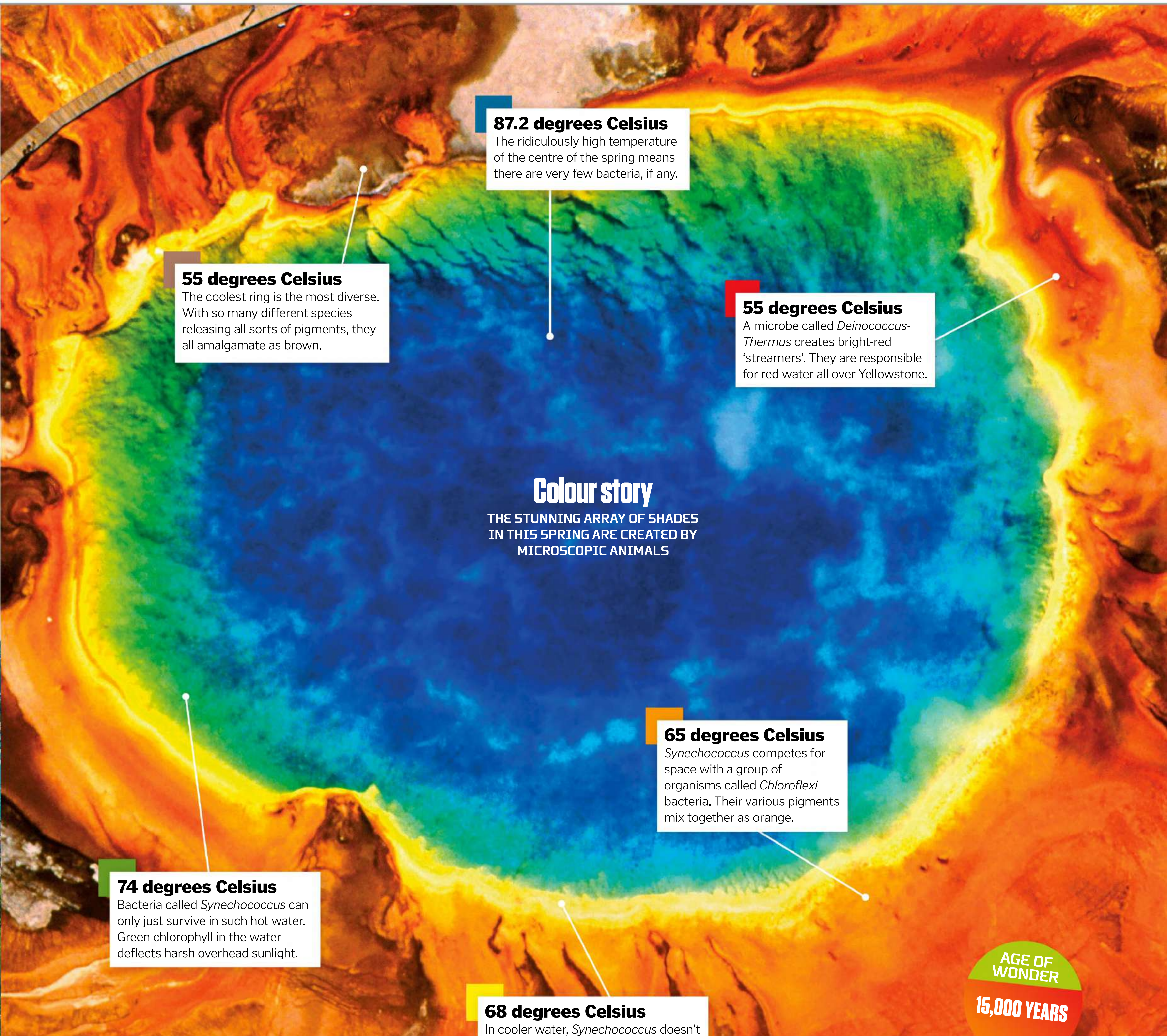
4 Pestle and mortar Fragments at the bottom of the plunge pool grind the ground away as the waterfall's force swirls them around.



5 Slow retreat This process continues as time goes on. Given enough time it will crawl backwards as it erodes more of the hard rock at the peak.

© Illustrations by The Art Agency/Peter Scott

DID YOU KNOW? *Lava can be as hot as 1,200 degrees Celsius, and it only needs to cool by 50 degrees to start freezing*



Colour story

THE STUNNING ARRAY OF SHADES IN THIS SPRING ARE CREATED BY MICROSCOPIC ANIMALS

87.2 degrees Celsius
The ridiculously high temperature of the centre of the spring means there are very few bacteria, if any.

55 degrees Celsius
The coolest ring is the most diverse. With so many different species releasing all sorts of pigments, they all amalgamate as brown.

55 degrees Celsius
A microbe called *Deinococcus-Thermus* creates bright-red 'streamers'. They are responsible for red water all over Yellowstone.

65 degrees Celsius
Synechococcus competes for space with a group of organisms called *Chloroflexi* bacteria. Their various pigments mix together as orange.

74 degrees Celsius
Bacteria called *Synechococcus* can only just survive in such hot water. Green chlorophyll in the water deflects harsh overhead sunlight.

68 degrees Celsius
In cooler water, *Synechococcus* doesn't need as much protection. They create yellow carotenoids, the pigments in carrots and other root vegetables.

AGE OF WONDER
15,000 YEARS

Grand Prismatic Spring

LOCATION: **US**

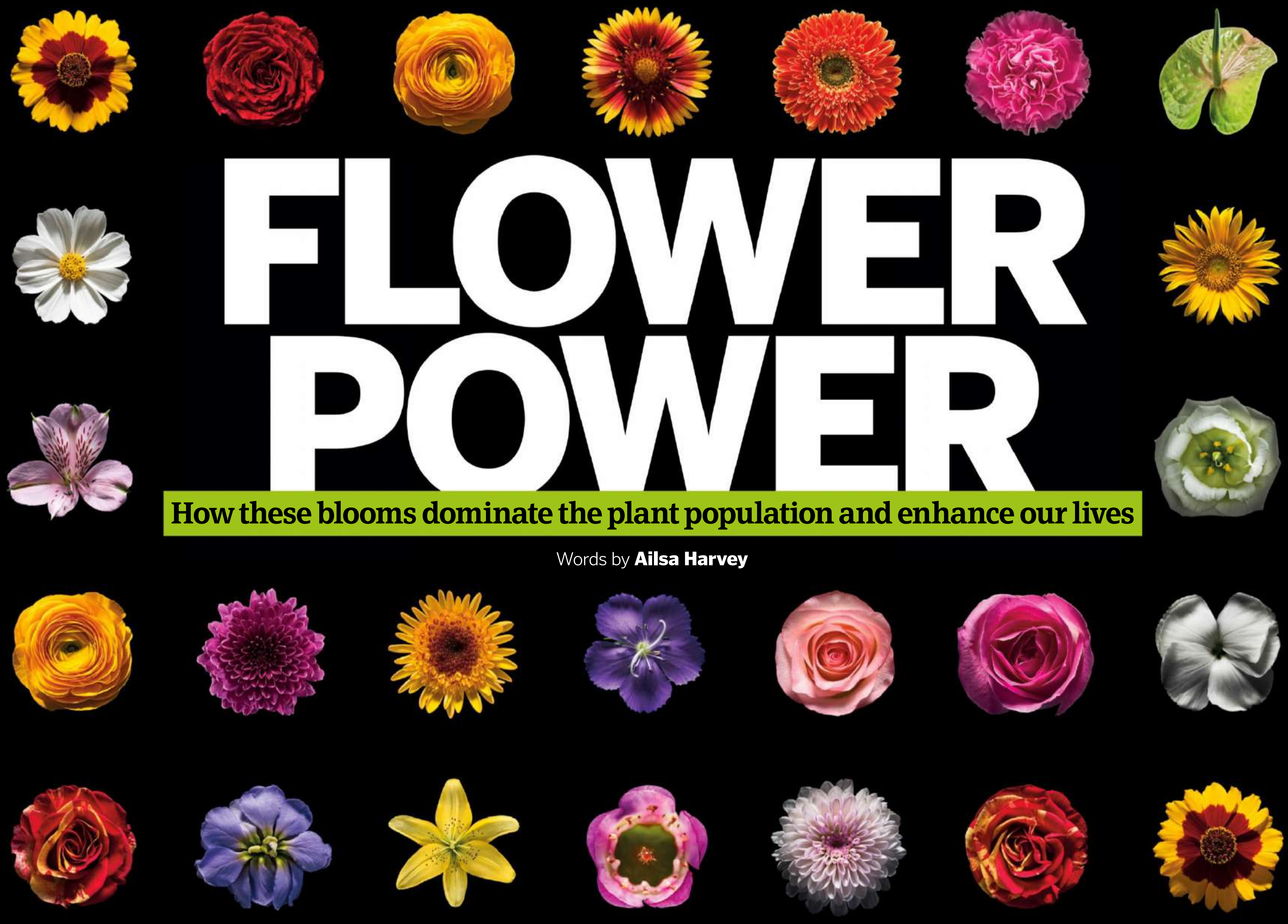
This stunning hot spring is 37 metres deep: a ten-storey building could fit inside it. It's the third-largest hot spring in the world, but what sets it apart is its glorious array of colours. Thousands of bacteria are responsible for the pool's rainbow effect. They are able to survive in water so hot that it could kill a human.

Studying these bacteria has led to some surprising scientific and medical advancements, including the Human Genome Project, which mapped human DNA.

This is a natural spring, not a geyser, so it doesn't erupt. Water in geysers has narrow channels to reach the surface, but in a hot spring it's unimpeded. Boiling water rises from deep inside the Earth. When it hits the cold air, it quickly starts to cool down. As it gets colder it starts to sink again, where it's reheated, and the cycle begins again.

© Getty

Grand Prismatic Spring is the most photographed attraction throughout the entirety of Yellowstone



FLOWER POWER

How these blooms dominate the plant population and enhance our lives

Words by **Ailsa Harvey**

There are about 369,000 flowering plant species known to grace our planet, making up roughly 94 per cent of all land plants. The flower itself is the seed-bearing part of flowering plants, containing the reproductive components. Unable to move from where their seed settled, plants rely on animals and other means of transport, like the wind, to spread their reproductive cells. To do this, they have evolved to become highly efficient charmers. By enticing the right species and deterring those that could destroy them, flowers thrive.

Humans are also attracted to them. Drawn to flowers of our favourite colours and shapes, we use these plants to embellish our gardens and garnish our food. We give them as gifts and even copy their smell by spraying floral-scented perfume over our bodies. We view flowers largely as a source of decoration, but the science behind their practical features shows some of their most impressive traits.

The intricacies of a flower's components aren't all for show. Having co-evolved with different animals, each species has unique shapes, sizes, colours and other features to help it survive. They thrive in their specific habitats with the resources they require, but one of the main reasons that these delicate specimens have done so well is that they too are depended on.

Bees are one of the most common pollinators, and have evolved alongside the flowers that they rely on. Their symbiotic relationship means that bees need the flowers' nectar to survive and pollen to reproduce, while flowers need the bees' flight to pass on their reproductive cells. Without this method of transport, flowers could only hope that their pollen would blow onto a nearby flower.

For millions of years, bees and flowers have evolved to fit the features of the other. The furry coat of many bees now uses electrostatic forces to cover itself in as much pollen as possible, while flowers have taken on the role of a bee service station. Some provide shelter for insects during their stay at the flower and offer sweet, sugary treats to fuel bees for the remainder of their role as pollinators.

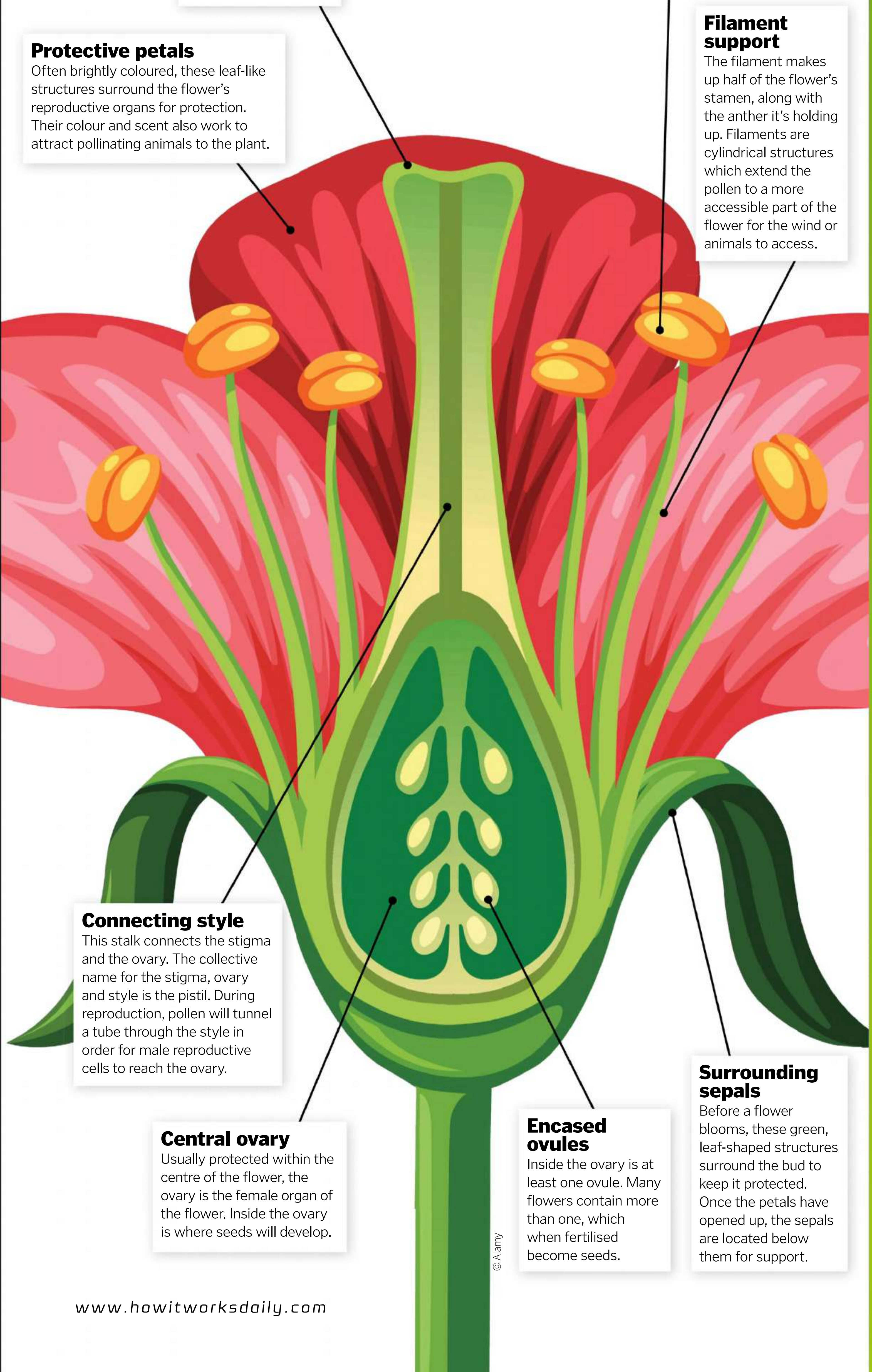
The power held by flowers came about to keep themselves alive. Being such dominant life forms, flowers are now depended on by the entire planet. Without them, the world wouldn't just be less colourful: ten per cent of the moisture in the atmosphere comes from plants, with flowering plants being the most efficient at transpiration. This is the movement of water through a plant's tissue, resulting in evaporation into the atmosphere. Without this, drier landscapes would reduce the number of species that could survive, limiting the biodiversity of Earth.

The survival of pollinators, who have evolved to depend on these plants, would be almost impossible. And as for humans, much of our diet that relies on flowers' reproductive processes would vanish, making it difficult to support our growing population. Whether they're feeding other species directly or as part of a chain, flowers hold the power to keep the world's ecosystems alive.

© Getty

Anatomy of a flower

Peel back the petals of these pretty plants



© Alamy

Sticky stigma
Reaching up at the highest point of the flower, the job of the stigma is to catch pollen. Its sticky surface will capture any pollen that comes into contact with it.

Pollen producers
These round sacs are called anthers. Pollen grains are produced inside, which contain the flower's male reproductive cells. Many grains of pollen are stored on the anthers, ready for their journey to another plant.

Protective petals
Often brightly coloured, these leaf-like structures surround the flower's reproductive organs for protection. Their colour and scent also work to attract pollinating animals to the plant.

Filament support
The filament makes up half of the flower's stamen, along with the anther it's holding up. Filaments are cylindrical structures which extend the pollen to a more accessible part of the flower for the wind or animals to access.

Connecting style
This stalk connects the stigma and the ovary. The collective name for the stigma, ovary and style is the pistil. During reproduction, pollen will tunnel a tube through the style in order for male reproductive cells to reach the ovary.

Central ovary
Usually protected within the centre of the flower, the ovary is the female organ of the flower. Inside the ovary is where seeds will develop.

Encased ovules
Inside the ovary is at least one ovule. Many flowers contain more than one, which when fertilised become seeds.

Surrounding sepals
Before a flower blooms, these green, leaf-shaped structures surround the bud to keep it protected. Once the petals have opened up, the sepals are located below them for support.

FIVE TYPES OF POLLEN TRANSPORT

Meet the main players in pollination

Insects

© Getty

Bees are the most efficient and well-known pollinators, having evolved to grow fine, branching hairs ideal for collecting pollen. However, thrips are the earliest known pollinators. Fossils of these millimetre-long winged insects have been found covered in pollen dating back 250 million years. Meanwhile, beetles are responsible for pollinating 88 per cent of the world's flowering plants, as sticky pollen grabs hold of their hard exoskeletons.

Reptiles

© Getty

Usually occurring within island ecosystems where reptiles often feast on fruit and nectar as part of their diet, lizards unknowingly carry pollen that has stuck to their scales. In desert landscapes, sometimes lizards rely on the nectar of cactuses to drink when water becomes too scarce. As they drink from the plant, they collect pollen on their bodies.

Mammals

© Alamy

There are many mammals that play a part in various flowering plants' survival. During the night, bats pollinate hundreds of flowers by covering their furry faces in pollen. One tree in particular – the baobab tree – relies almost completely on this mammal for pollination, opening its flowers at night for this purpose. One of the largest pollinators is the black lemur, which pushes its fluffy snout or paw into flowers to find nectar.

Birds

© Getty

Sunbirds, hummingbirds and parrots are among the bird species playing their role in pollination. Flowers pollinated by hummingbirds are often bright red in colour. These birds are attracted to red and are more likely to search for nectar inside these flowers. Bird-pollinated plants will often be long and tubular in shape. As a bird reaches inside with its long beak, its head gets dusted in pollen.

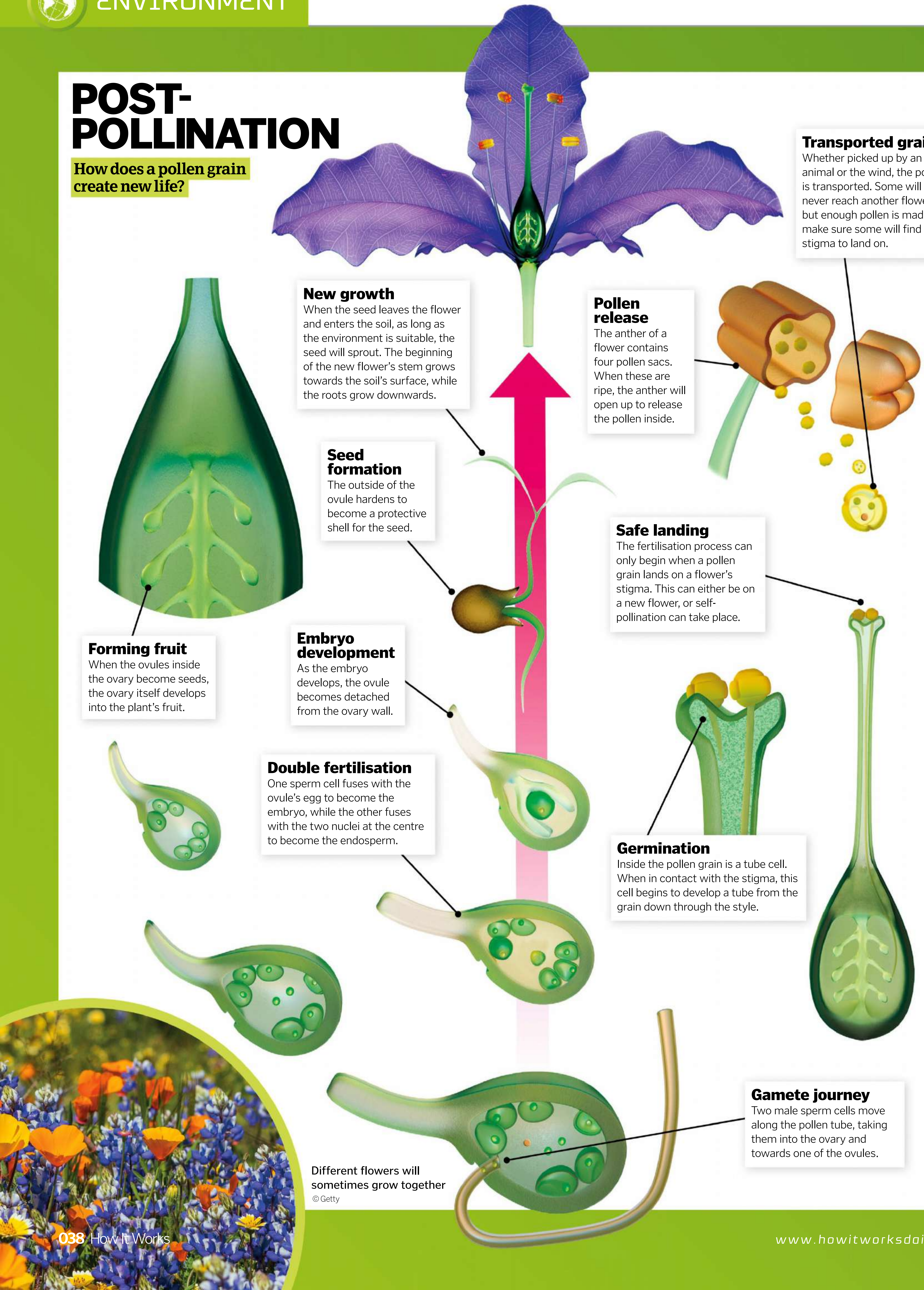
Wind

© Alamy

Not all pollinators are animals. Anemophily is the term used to describe the distribution of pollen by the wind. Plants relying on this method are less adapted to attract animal species and better adapted to increase the likelihood of transportation within air currents. Pollen will be lightweight and will be produced in large numbers. This makes it more likely that some of the pollen carried away will reach another plant.

POST-POLLINATION

How does a pollen grain create new life?



Pollen release
The anther of a flower contains four pollen sacs. When these are ripe, the anther will open up to release the pollen inside.

Transported grains
Whether picked up by an animal or the wind, the pollen is transported. Some will never reach another flower, but enough pollen is made to make sure some will find a stigma to land on.

Safe landing
The fertilisation process can only begin when a pollen grain lands on a flower's stigma. This can either be on a new flower, or self-pollination can take place.

Germination
Inside the pollen grain is a tube cell. When in contact with the stigma, this cell begins to develop a tube from the grain down through the style.

Gamete journey
Two male sperm cells move along the pollen tube, taking them into the ovary and towards one of the ovules.

Double fertilisation
One sperm cell fuses with the ovule's egg to become the embryo, while the other fuses with the two nuclei at the centre to become the endosperm.

Embryo development
As the embryo develops, the ovule becomes detached from the ovary wall.

Seed formation
The outside of the ovule hardens to become a protective shell for the seed.

New growth
When the seed leaves the flower and enters the soil, as long as the environment is suitable, the seed will sprout. The beginning of the new flower's stem grows towards the soil's surface, while the roots grow downwards.

Forming fruit
When the ovules inside the ovary become seeds, the ovary itself develops into the plant's fruit.

© Getty

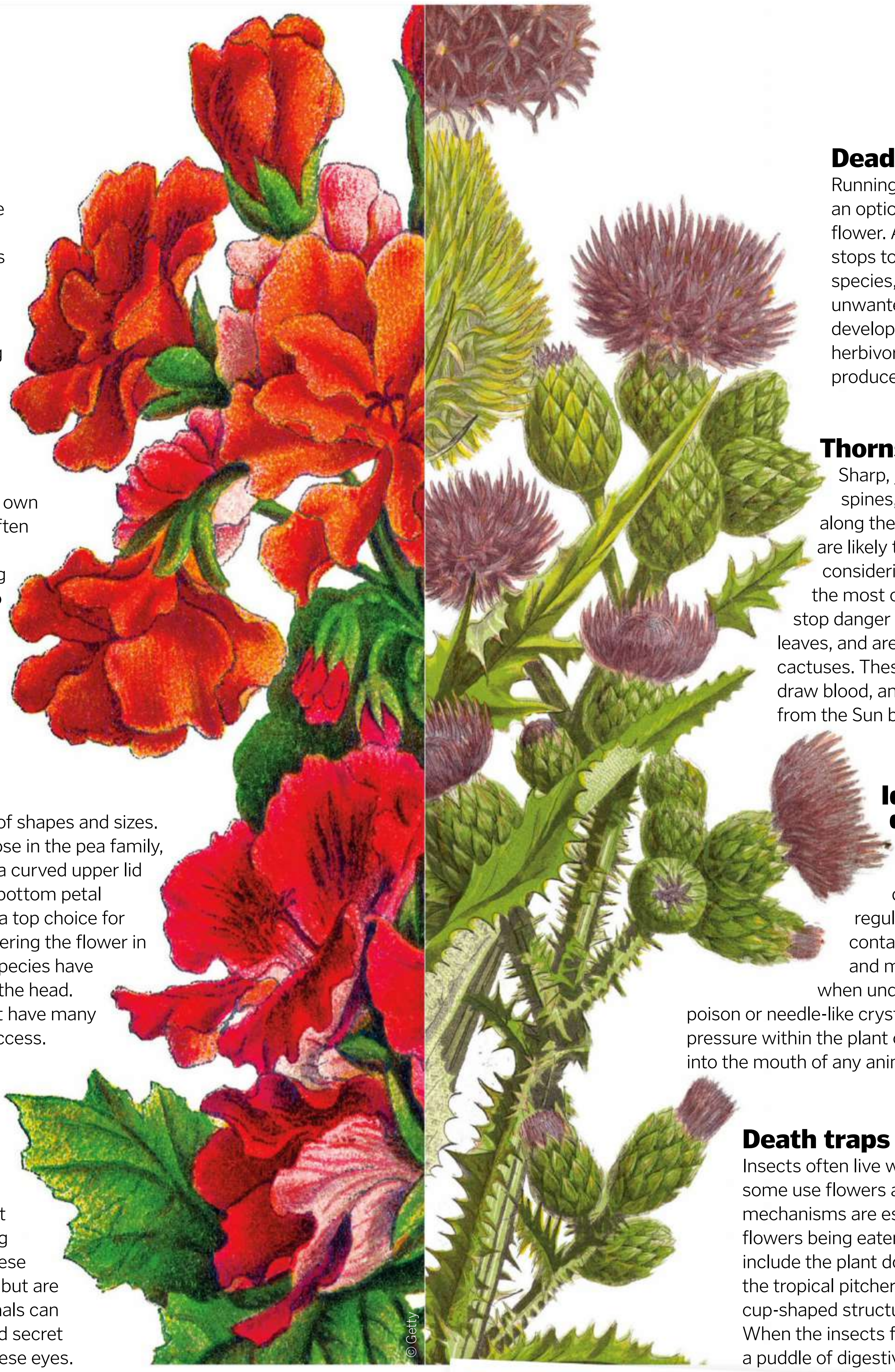
Different flowers will sometimes grow together

© Getty

DID YOU KNOW? *One milligram of poison from the Ricinus' seeds can kill a human*

ATTRACT VS ATTACK

How do flowering plants both coax pollinators and repel predators?


© Getty

ATTRACT

Flashy colours

The beauty and flamboyance we associate with some flowers didn't occur by accident. Flowers are competing with each other to win over the birds, the bees and other important pollinators. As the most colourful parts of the flower are often the petals surrounding the nectar, they act as a visual target to guide pollinators.

Natural perfume

Each species produces its own unique scent. These are often dictated by their primary pollinators. Sweet-smelling flowers attract bees, while those aiming to attract beetles smell musty or rotten. This might not sound appealing to us, but each pollinator has a unique preference. Flowers with multiple pollinators can create different scents for each.

Pleasing shapes

Flowers grow in a variety of shapes and sizes. Some flowers, such as those in the pea family, have a lipped shape, with a curved upper lid and one underneath. The bottom petal serves as a platform for pollinators, and is a top choice for insects wishing to land and rest before entering the flower in search of nectar. Some daisies and other species have many tiny bud-shaped structures forming the head. These are covered in pollen and nectar, but have many tiny gaps, ideal for delicate butterflies to access.

Secret markings

Linear patterns can sometimes be seen on flowers. These might point towards the centre, being useful for guiding pollinators to the right area. Sometimes these markings can't be seen by the human eye, but are visible to insects such as bees. These animals can see in ultraviolet light, and petals often hold secret markings that can only be seen through these eyes.

ATTACK

Deadly poison

Running from danger isn't an option for a stationary flower. After pulling out the stops to attract a beneficial species, it needs a backup for when unwanted animals approach. Some flowers develop poisonous fruits or leaves to prevent herbivores from eating them, while others produce toxins upon being attacked.

Thorns and spines

Sharp, jagged thorns and spines, periodically spaced along the stem of a flower, are likely to put off any animal considering it as a snack. These are some of the most obvious signs of defence, working to stop danger before it arises. Spines are modified leaves, and are a predominant characteristic of cactuses. These are so sharp that they can easily draw blood, and protruding out adds extra defence from the Sun by creating areas of shade.

Idioblast detonation

An idioblast is a specialised cell that differs from the regular cells surrounding it. They can contain a range of materials, chemicals and minerals. Perhaps the most useful when under threat are those containing poison or needle-like crystals. When the cell is torn, the water pressure within the plant causes its contents to burst out and into the mouth of any animal whose bite caused the damage.

Death traps

Insects often live within plants, and some use flowers as food. Defence mechanisms are essential to stop flowers being eaten, and these can include the plant doing the eating itself. One example is the tropical pitcher plant. These flowering plants grow cup-shaped structures which act as traps for insects. When the insects fall in, they get stuck at the bottom in a puddle of digestive fluid, which kills them.

© Getty x8

What makes a flower 'perfect'?

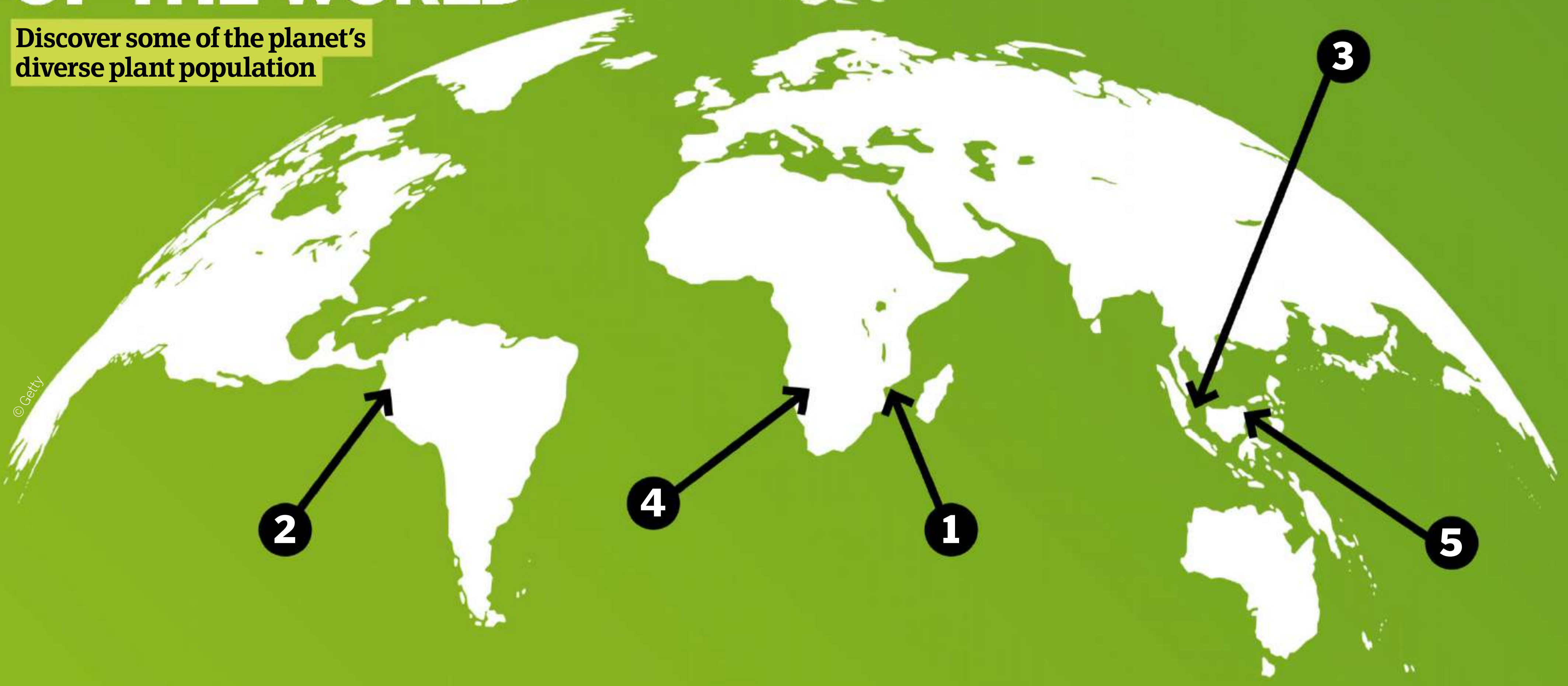
A flower enthusiast might describe their favourite species as the 'perfect' flower, but scientifically speaking a perfect flower is one that has both male and female reproductive parts. This enables the plant to use its own pollen to reproduce. The alternative is an imperfect flower. Either containing just the male organs or just the female organs, imperfect flowers cannot self-pollinate. Plants with imperfect flowers often have two types of flower growing on them – one male and one female. An example of this is corn. The male flower, known as the tassel, grows at the top of the corn plant, and female flowers, called ears, grow underneath to catch the pollen.

The male tassel containing the pollen can be seen growing at the top of this corn plant

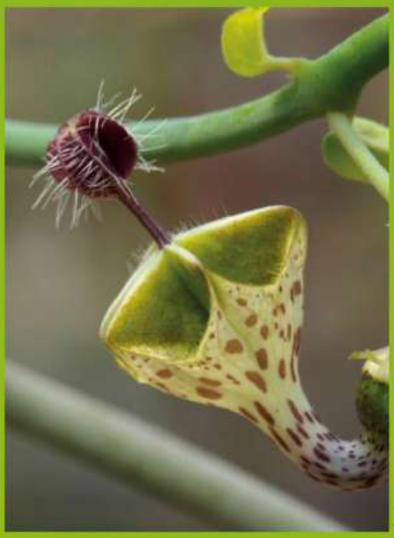
© Getty

WEIRD FLOWERS OF THE WORLD

Discover some of the planet's diverse plant population



© Getty



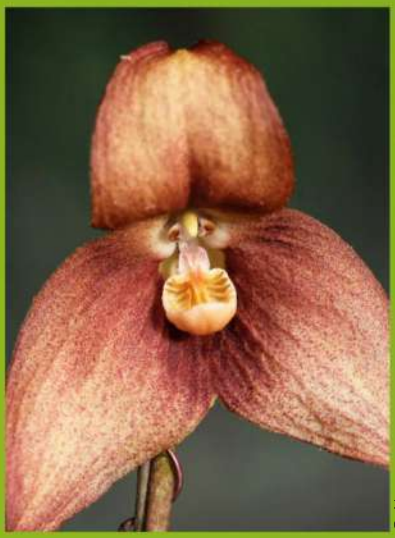
© Alamy

The cunning parachute plant

ESWATINI, MOZAMBIQUE AND SOUTH AFRICA

1 The parachute plant has mastered its method of hunting food and ensuring pollination: it mimics its victims' food source. The unsuspecting victims are flies of the *Desmometopa* genus, which feast on honeybees. When one of these bees is killed, the flies are alerted to the presence of distress chemicals. Pheromones released by the bees have a distinct smell to the flies, and it is this smell that the flower recreates. The flower is capable of producing 33 of the same substances as a dying honeybee.

As its name suggests, the flower of the parachute plant is similar in shape to a parachute, containing a bending trap. When the flies fly towards what they think is their next meal, they follow the fragrance right into the parachute trap.



© Alamy

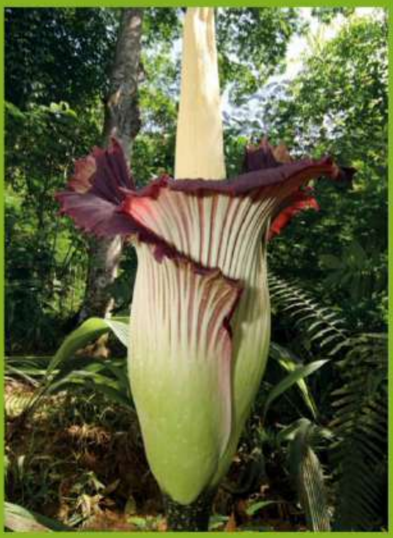
Orchid with a monkey's face

ECUADOR AND PERU

2 The monkey-face orchid got its weird name from the fact that the flower looks uncannily like the face of a primate – perhaps a baboon, or a Proboscis monkey with its strangely enlarged nose. Nature has produced this flower-monkey combination, creating a frighteningly mammal-like appearance within this orchid's petals. The botanical name for monkey-face orchids is *Dracula simia*. Dracula refers to the fang-like structures that hang from the sides of this flower, while simia means 'monkey' in Latin.

A proboscis monkey

© Getty

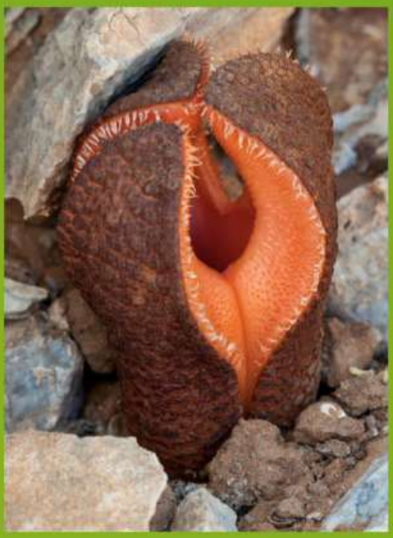


© Getty

A pungent corpse flower

INDONESIA

3 What does a flower smell like? It's likely that the majority of the flowers you have encountered have had a pleasant scent. But unless you enjoy the strong smell of rotting meat, you won't want to be in the same vicinity as this beast of a flower. The corpse flower has good reason for smelling so bad, as its main pollinators include dung beetles and carnivorous insects. It's one of the world's largest flowers, and its towering central spike can generate heat up to 36.7 degrees Celsius. The combination of its foul smell and radiating heat make insects explore the flower in search of a body. They won't find one, but in their hunt they will pick up pollen from the flower to pass onto another.

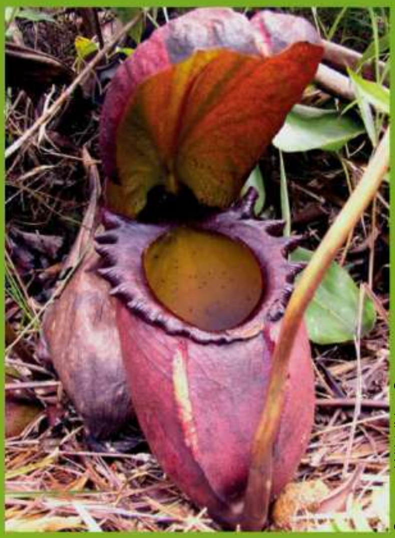


© Alamy

The parasitic *Hydnora africana*

NAMIBIA AND SOUTH AFRICA

4 One of the main oddities of *Hydnora africana* is that it doesn't resemble a typical flower. It has no leaves or stem and can't survive without the presence of another plant. Growing on the roots of *Euphorbiaceae*, which is a diverse genus of flowering plants, this flower first forms below ground. After its brown, bristly shell and soft orange inside have formed, the flower emerges through the earth. This only happens if enough rain has fallen to moisten the soil first. The fruit produced by this flower grows underground and is called jackal food.



Source: Wiki/NepGrower

Giant rat-eating pitcher plant

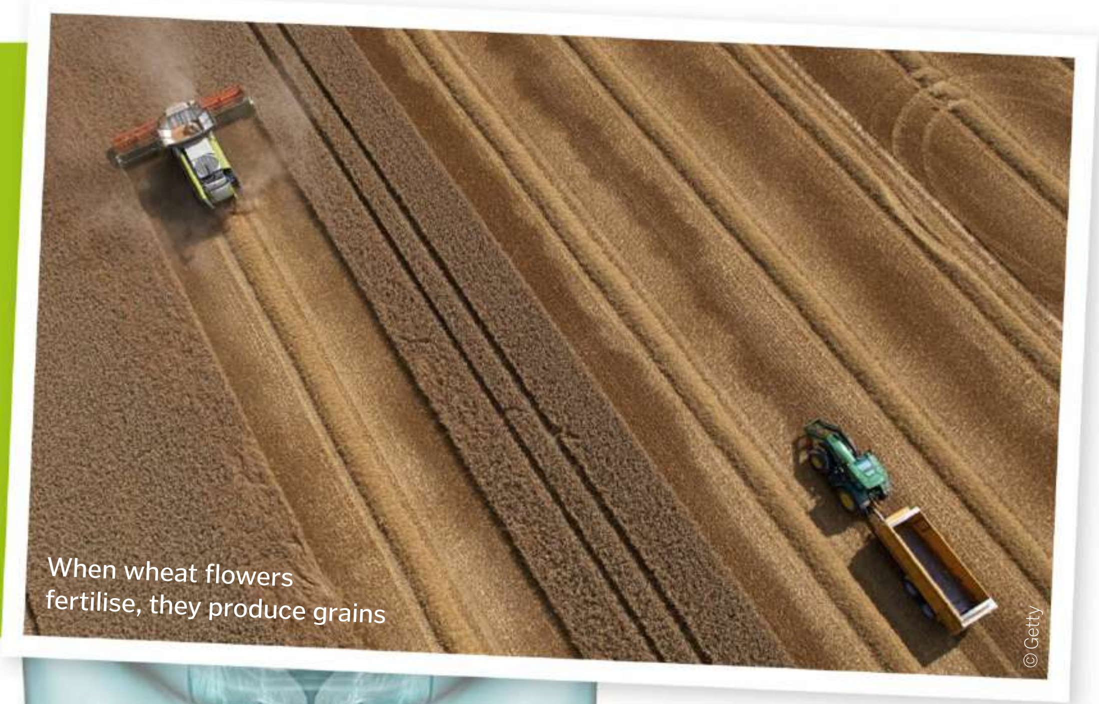
MALAYSIAN BORNEO

5 The cup-shaped structures on this flowering plant can grow more than a metre long. As nectar is secreted around the tops of the cups, animals such as rodents are drawn to the top of this dangerous cavity. When one of these unfortunate creatures falls in, it is unable to scale the slippery and sheer plant walls, and will drown in the liquid inside. The dead animal is then attacked by enzymes in the plant to break down the body into nutrients that will feed the plant. It also has a mutualistic relationship with mountain treeshrews, which will defecate into the plant's pitcher as they feed on the nectar. Its scientific name is *Nepenthes rajah*, and it can flower all year round.

Flowers for food

In any one day, it's estimated that one-third of the food we consume relies on pollination. This process provides us with seeds, beans, fruit and vegetables – all of which we are able to eat. Whether it's directly or indirectly, so much of our food relies on flowering plants. The oils we use to cook and flavour our food can come from sunflowers or olives, the coffee beans in our morning brew come from flowering plants and many of our essential vitamins come from the fresh produce of pollination.

Indirectly, much of the livestock we raise to eat are also fed with grains such as wheat and maize. These seeds are formed when flowers are fertilised, and whether we eat them ourselves or feed our food with them, the energy they release plays some part in keeping our species alive.



When wheat flowers fertilise, they produce grains

© Getty

MEDICINAL POWER

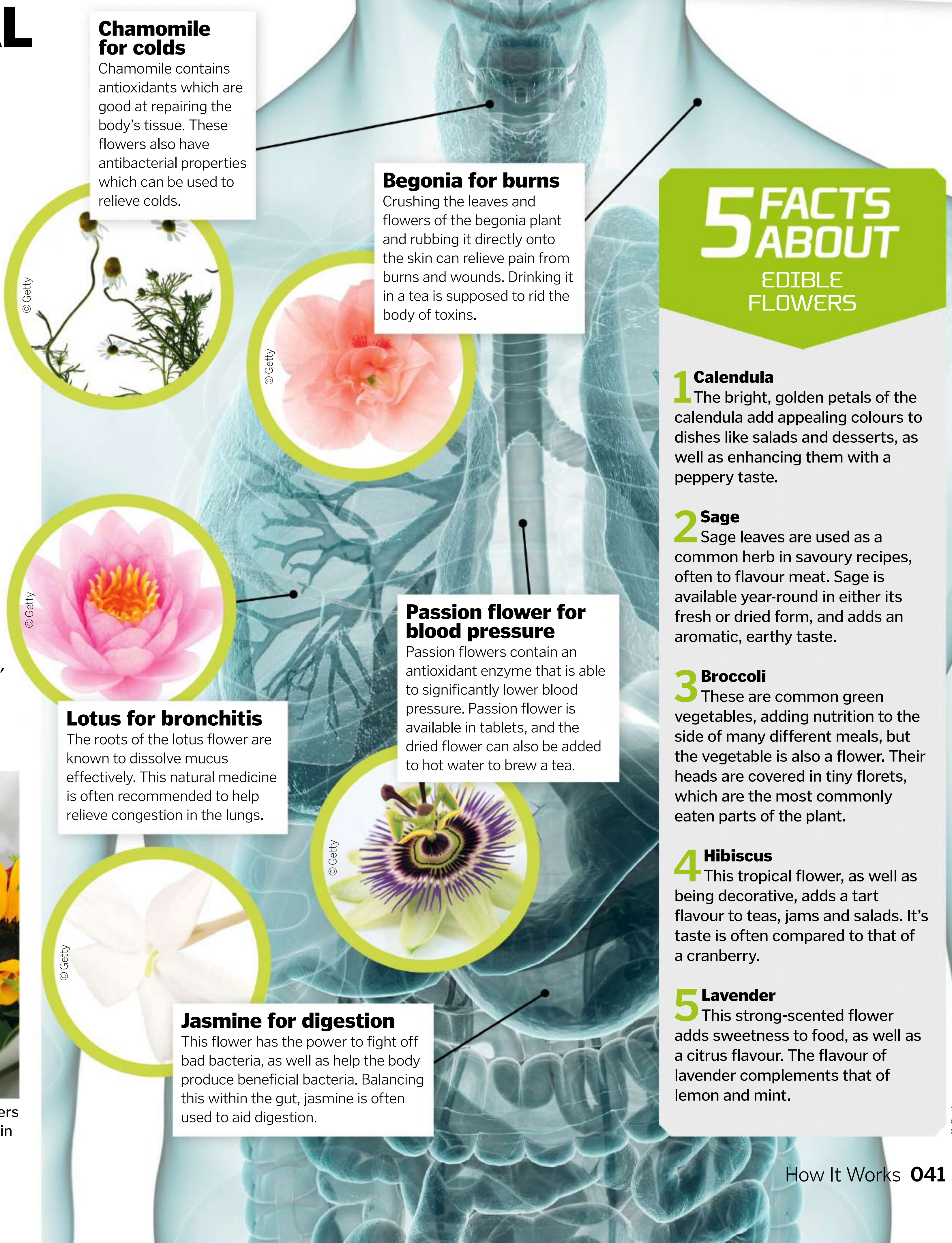
How do floral species benefit human health?

Flowers are likely to have been used to heal people since before written records began. Not only are flowers used directly in medicine to improve physical health, they can also help us feel better by enhancing our emotional health. Adding colour and fragrance to a room, flowers can boost our mood just by surrounding us. For this reason bunches of flowers are often bought as celebratory gifts or to help someone feel better as an addition to a hospital room. Evidence also shows that the presence of flowers can improve our memory as they work to oxygenate the air. These added benefits work in our environment, often without us realising, but how are these flowers actively used to target ailments?

Get well soon!

© Getty

Studies suggest being exposed to flowers can cause people to experience less pain



© Getty

Chamomile for colds
Chamomile contains antioxidants which are good at repairing the body's tissue. These flowers also have antibacterial properties which can be used to relieve colds.

Begonia for burns
Crushing the leaves and flowers of the begonia plant and rubbing it directly onto the skin can relieve pain from burns and wounds. Drinking it in a tea is supposed to rid the body of toxins.

Lotus for bronchitis
The roots of the lotus flower are known to dissolve mucus effectively. This natural medicine is often recommended to help relieve congestion in the lungs.

Passion flower for blood pressure
Passion flowers contain an antioxidant enzyme that is able to significantly lower blood pressure. Passion flower is available in tablets, and the dried flower can also be added to hot water to brew a tea.

Jasmine for digestion
This flower has the power to fight off bad bacteria, as well as help the body produce beneficial bacteria. Balancing this within the gut, jasmine is often used to aid digestion.

5 FACTS ABOUT EDIBLE FLOWERS

1 **Calendula**
The bright, golden petals of the calendula add appealing colours to dishes like salads and desserts, as well as enhancing them with a peppery taste.

2 **Sage**
Sage leaves are used as a common herb in savoury recipes, often to flavour meat. Sage is available year-round in either its fresh or dried form, and adds an aromatic, earthy taste.

3 **Broccoli**
These are common green vegetables, adding nutrition to the side of many different meals, but the vegetable is also a flower. Their heads are covered in tiny florets, which are the most commonly eaten parts of the plant.

4 **Hibiscus**
This tropical flower, as well as being decorative, adds a tart flavour to teas, jams and salads. It's taste is often compared to that of a cranberry.

5 **Lavender**
This strong-scented flower adds sweetness to food, as well as a citrus flavour. The flavour of lavender complements that of lemon and mint.

© Getty

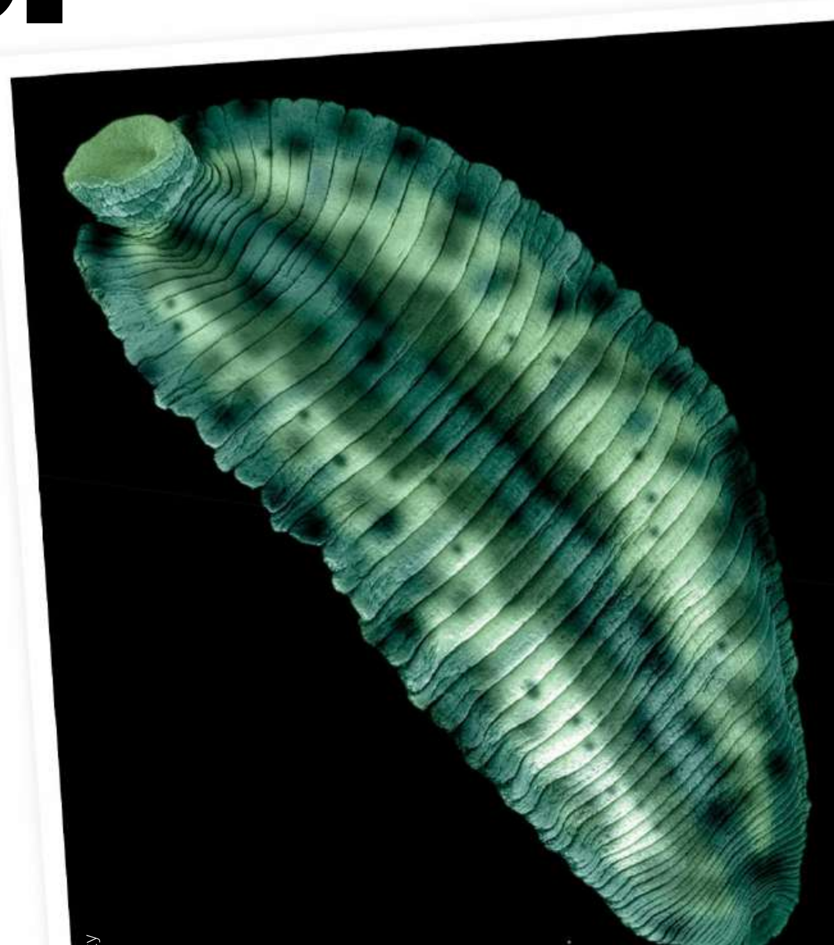
Inside the body of a blood-sucker

How leeches latch on your skin and feed through your flesh

There are around 700 species of leech worldwide, living in both aquatic and moist terrestrial environments. Most leeches are sanguivorous, meaning they feed predominantly on the blood of other creatures. Their choice of meal, however, differs between species. Some enjoy the taste of other aquatic animals, such as invertebrates, fish and frogs, while others set their sights on larger meals from mammals and birds.

As pesky parasites, leeches drink around 5 to 15 millilitres in a single feed, usually sucking at the source for 20 to 40 minutes. Blood loss is minimal for humans after a leech bite, but can be irritating, similar to a bee sting.

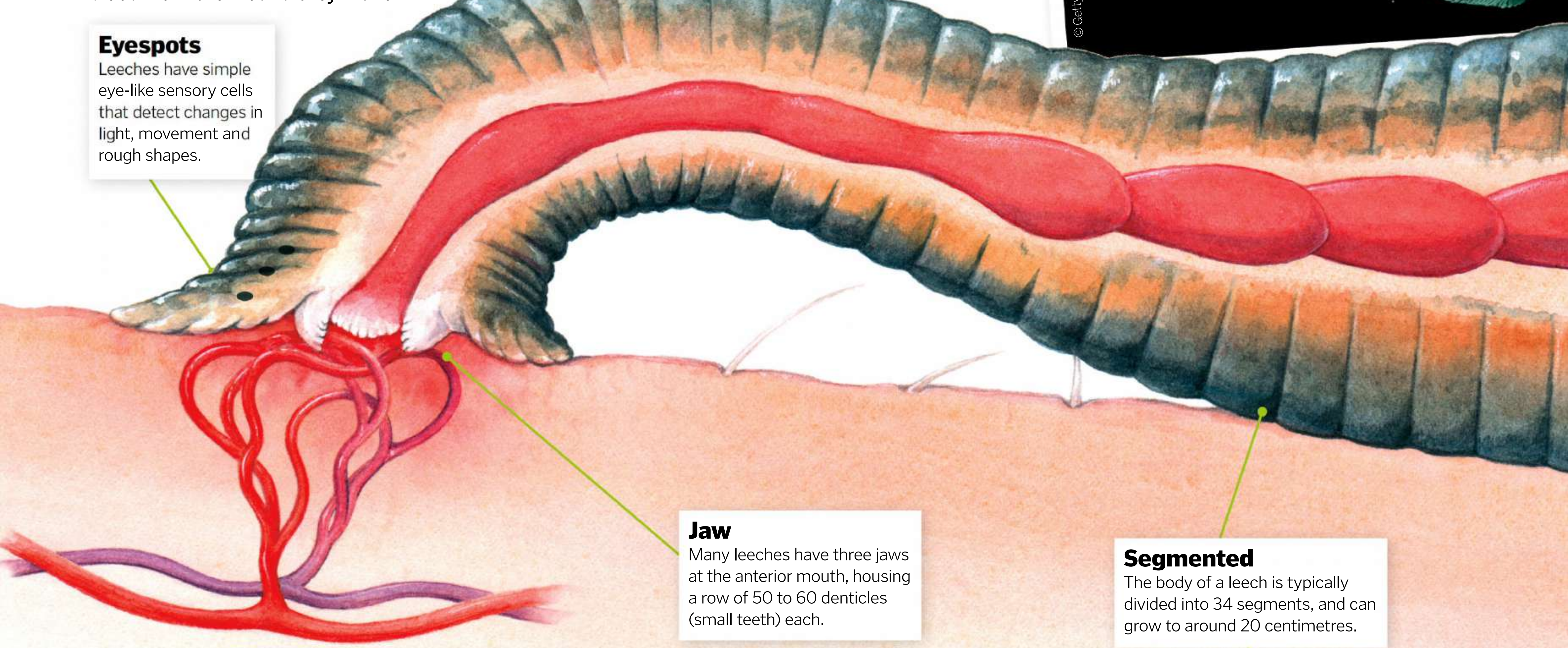
There are a couple of different ways that leeches extract blood from their hosts. Some species are equipped with a jaw full of teeth to bite through the skin and drink the outpouring blood. Others have a needle-like tongue called a


A coloured scanning electron micrograph (SEM) image of a leech

© Getty

Anatomy of a bite

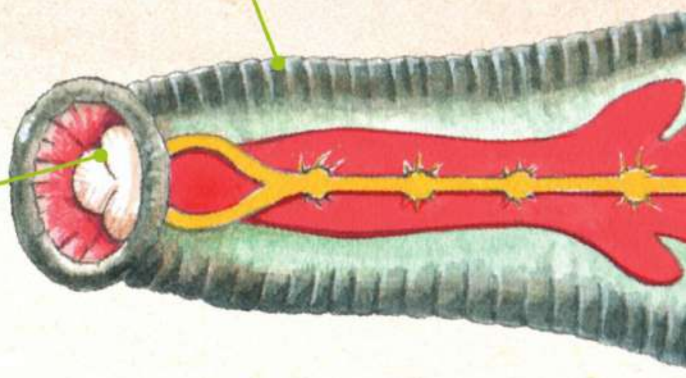
These vampiric invertebrates suck blood from the wound they make



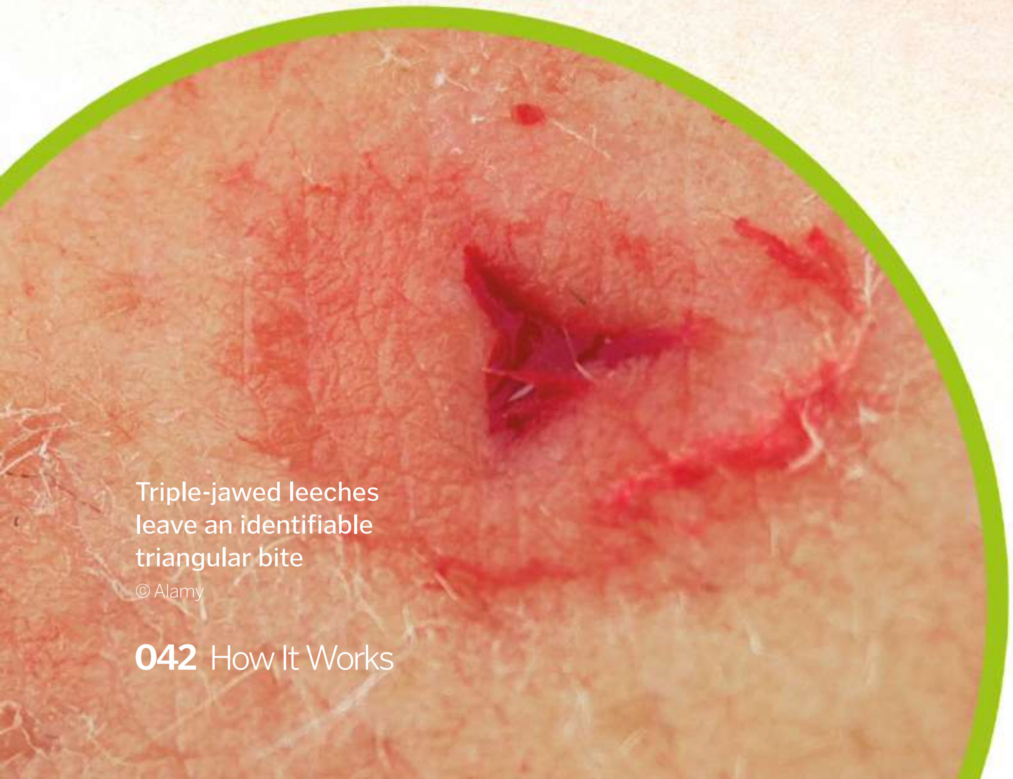
Eyespots
Leeches have simple eye-like sensory cells that detect changes in light, movement and rough shapes.

Jaw
Many leeches have three jaws at the anterior mouth, housing a row of 50 to 60 denticles (small teeth) each.

Segmented
The body of a leech is typically divided into 34 segments, and can grow to around 20 centimetres.



Salivary glands
Glands near the leech's jaw secrete anticoagulants to stop blood from clotting.


Triple-jawed leeches leave an identifiable triangular bite

© Alamy

DID YOU KNOW? *The largest species is the giant Amazon leech, growing to around 46 centimetres long*

proboscis that punctures the skin to syphon blood from beneath.

A host's body will naturally use proteins in the blood to clot blood cells at the site of a wound to prevent excess blood from escaping in a process called coagulation. To stop this from happening, leeches release either a secretion called hirudin or an enzyme called haematin that stops the process of clotting from occurring. This allows them to feed on their host for up to 60 minutes before dropping off with a full belly of blood. Once they've had their fill, leeches retire to a dark hole in the ground to digest all the blood stored in their bodies. There is another group of leeches, called *Pharyngobdellida*, that skips blood-sucking all together and devours their small invertebrate prey whole.

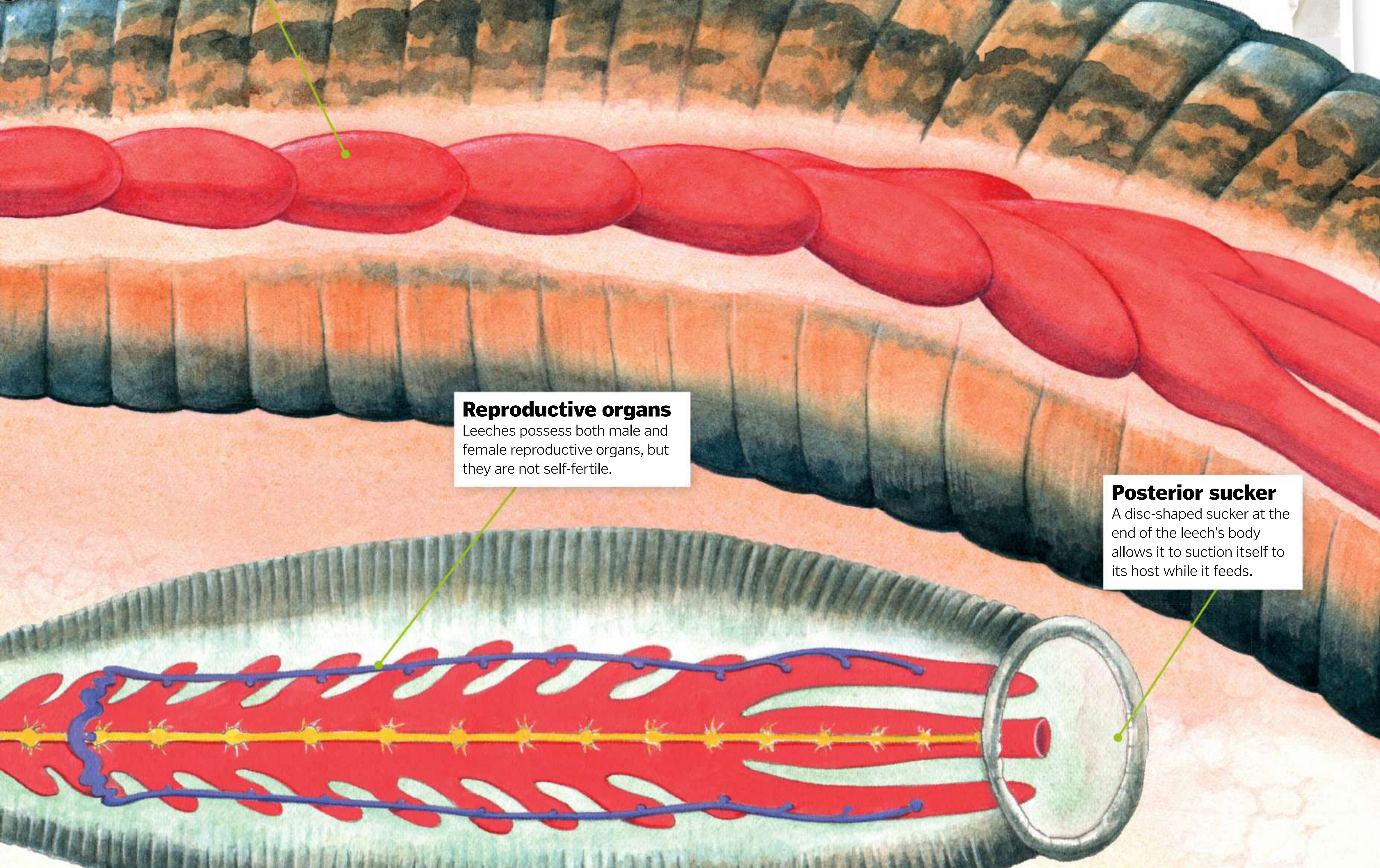
Parasite therapy

Leeches have made a resurgence in the medical industry in recent years. These blood-suckers have been used as medical remedies even before the reign of the Roman Empire. During the 18th and 19th centuries, leeches reached their professional peak as 'bloodletting' became common practice to treat a whole host of illnesses. However, as advancement in medicine continued, leeches were left by the wayside until the late 1900s.

Today leeches are once again used to treat a range of conditions, such as arthritis and varicose veins, as well as in cosmetic surgery to treat the skin during the healing process. There have also been some anticoagulant drugs produced that are derived from leech saliva.

Leech therapy can help with poor blood circulation and removing blood clots

© Alamy



Blood crop
Blood pools into several pouches running along the leech's body, awaiting digestion.

Reproductive organs
Leeches possess both male and female reproductive organs, but they are not self-fertile.

Posterior sucker
A disc-shaped sucker at the end of the leech's body allows it to suction itself to its host while it feeds.

© Illustration by The Art Agency/Peter Scott

COULD WE BUILD JURASSIC PARK?

Words by **Ailsa Harvey**

As science advances, we may find bringing dinosaurs back to life is a realistic prospect

© Alamy

KNOW? *Scientists have determined that DNA has a half-life of 521 years*

Welcome to Jurassic Park. As we open the gates to this zoo of previously extinct creatures, how would you expect the dinosaurs behind them to look? For those who have read or watched *Jurassic Park*, the image of a dinosaur may have already been planted in your mind. Your perception might be plagued by the gruesome scenes of park rangers becoming easy meals, or the film's iconic theme tune might resonate in your head as you envisage herds of long-necked beasts parading across the land. With great diversity between species, the thrill of this dinosaur park cannot be denied. But what about its accuracy?

When Michael Crichton first conceived the *Jurassic Park* story in the late 1980s, one of the last things he wrote was perhaps the most significant. How would the scientists in the story obtain the DNA needed to create a theme park of dinosaurs? This would be the key to the entire plot, giving the story a feeling of scientific realism. Eventually, Crichton was inspired by a scientific paper he read. The paper referenced a fly that had been found preserved inside hardened tree resin. Somehow, at the end of its life, the fly had ended up submerged in this resin time capsule. This was not just the stroke of genius that led to the creation of this fictional land, but a real-life discovery. Together the story of *Jurassic Park* and the science at the centre of the tale would inspire the next generation of palaeontologists, opening the world's imagination to dinosaurs.

What might fascinate people most about dinosaurs is the multitude of unanswered questions, with only hints at their dominance before our time. What did dinosaurs really look like, and how did their unique appendages assist them as they scoured the land in diverse groups?

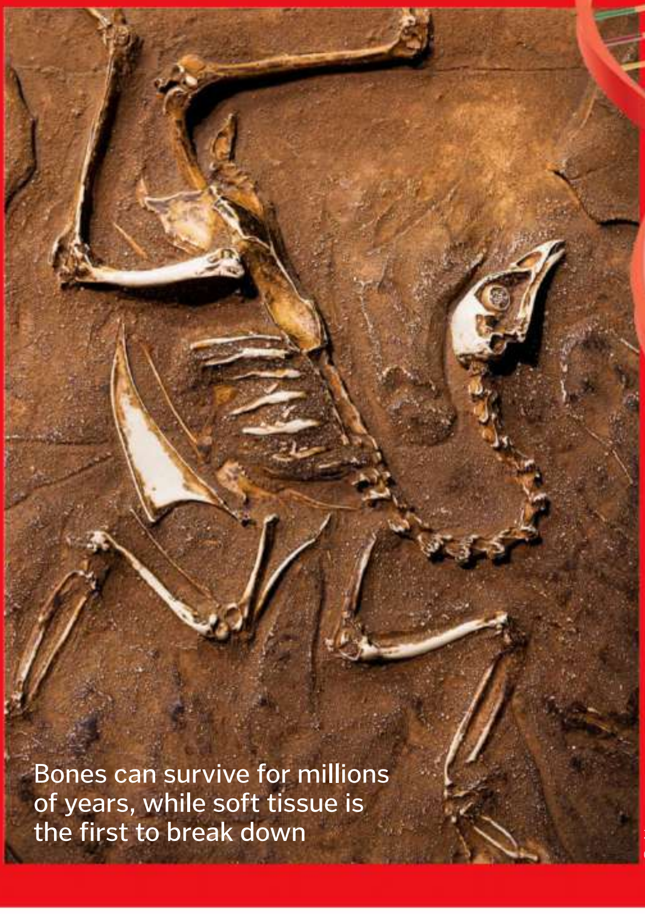
As humans have never lived alongside dinosaurs, nobody holds the answers to some of the questions asked by children and adults alike. We continue to learn more about dinosaurs as interest and research grows – and with new fossil finds – and we have now discovered more than 700 dinosaur species worldwide, but as time passes by, it separates these ancient beasts further from us into the past.

Scientists are currently working to reverse extinction by bringing animals that vanished from Earth long ago back into our lives. By editing the genetic code in the DNA of extinct animals' closest living relatives, scientists can slowly build backwards and manipulate a model of the species' DNA. One of the most high-profile cases involves the woolly mammoth, which died out around 4,000 years ago. Their DNA is preserved in the frozen soil of Siberia, so some scientists are working on a project to combine these fragments of genetic code with that of living elephants. There might be thousands of years separating these species – and over 60 million years for dinosaurs – but if scientists are successful in producing these extinct species, this could be a stepping stone towards the beginning of a true Jurassic Park.

Have we found dinosaur DNA?

The biggest hurdle to overcome before we can create a dinosaur park is how to source the main ingredient. Without access to dinosaur DNA, we can't clone true dinosaurs. New fossils are being uncovered from the ground every day. However, while this can provide important evidence of a species' form, its organic material has long disappeared. Instead of bone is the rock and sediment that has filled its place. While these clues can tell us about a specimen's shape, size, the time it was alive and any unique features that the animal had, it is unable to give us the crucial genetic information.

In 2020, researchers from the US and China discovered cartilage that they believe to contain dinosaur DNA. Many palaeontologists are incredibly sceptical about this claim, as it is widely believed that it's impossible for the protein in these molecules to survive for millions of years. The cartilage, from the Hypacrosaurus species of the Cretaceous Period, is over 70 million years old, but has been calcified and fossilised, which may have protected the inside of the cells.



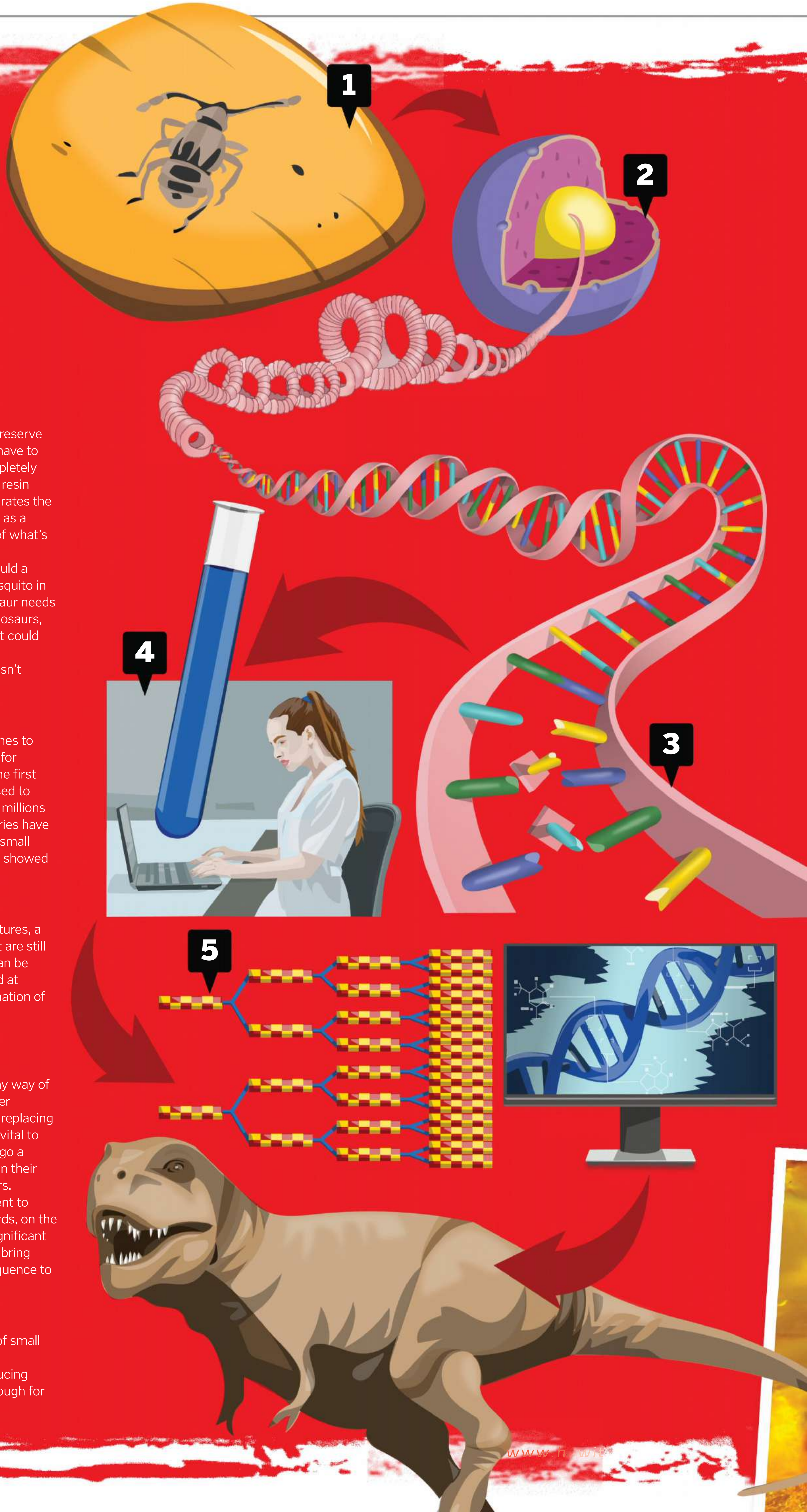
Bones can survive for millions of years, while soft tissue is the first to break down

© Alamy

© Getty

CLONING DINOSAURS

Follow the method seen in *Jurassic Park* to extract dinosaur DNA and decipher the true science from the fiction



THE TRAPPED MOSQUITO

1 Amber is fossilised tree resin, which has been known to preserve small organisms. To become preserved, an insect would have to have died as the resin hardened around it, or have been completely covered in the resin soon after its death. Buried in sediment, resin hardens under the extreme pressure and heat. Amber dehydrates the organism inside, which helps to slow its decay. It also serves as a protective shell, and as it hardens creates a perfect imprint of what's trapped inside.

Insects are small enough to be encapsulated, but how would a dinosaur's DNA end up in this resin? The idea behind the mosquito in *Jurassic Park* is that only the genetic material from the dinosaur needs to be preserved. Mosquitoes existed at the same time as dinosaurs, and it's possible that a mosquito with dinosaur blood inside it could have become trapped in resin. However, over time blood will decompose, and scientists have found that this material doesn't preserve DNA as well as harder outer tissue.

CELL SURVIVAL

2 Bones and teeth are relatively common finds when it comes to dinosaur hunting. But what about the soft tissue needed for cloning? Soft tissue, containing gene-packed living cells, is the first thing to vanish when fossils are forming. Palaeontologists used to accept that the survival of any soft tissue over the course of millions of years was impossible, but in recent years unlikely discoveries have suggested otherwise. In 2005, Mary Schweitzer discovered small amounts of protein inside the leg of a *T. rex* in Montana. This showed how new discoveries can redefine what is possible.

MAKING A STRAND

3 In order to clone an animal with all the same physical features, a complete genome needs to be retrieved. For animals that are still alive, or died out more recently, collecting this information can be simple. Any potential dinosaur DNA that has been discovered at present has been in small fragments. This is due to a combination of ultraviolet light, cosmic radiation and enzymes breaking down proteins.

THE FROG ADDITION

4 As the DNA source is unlikely to be complete, is there any way of replacing the material that has been lost? Without further supplies of dinosaur DNA, the story of *Jurassic Park* involves replacing missing fragments with frog DNA. The use of frog DNA was vital to the plot for population control. Some frog species can undergo a biological change from female to male in order to breed when their species is under threat. This trait was passed to the dinosaurs.

In reality, as frogs are amphibians, they are entirely different to dinosaurs, and their DNA is nowhere near similar enough. Birds, on the other hand, are descended from dinosaurs, and may have significant similarities. The best hope for palaeontologists who want to bring back dinosaurs is to wait for a well-preserved, large DNA sequence to be found.

CREATING COPIES

5 One method that can be used to create multiple copies of small DNA fragments is a polymerase chain reaction. Using a heat-resistant enzyme, a strand of DNA can be copied, producing millions of identical strands and providing a sample large enough for the order of amino acids to be analysed and sequenced.

© The Art Agency/Nick Sellers

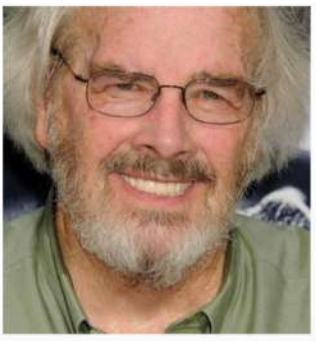
DID YOU KNOW? *The oldest known sample of amber was found to be 320 million years old*

© Alamy

A tiny embryo in a test tube. A genetically engineered dinosaur would start like this

Q&A JACK HORNER

Jurassic Park's scientific advisor has plans to make a pet dinosaur



© Alamy

Horner is the real palaeontologist who inspired the character of Dr Alan Grant in *Jurassic Park*. Since finding his first dinosaur bone at the age of eight, Horner has dug up the first dinosaur embryos, the first dinosaur eggs in the Western world and has discovered and named the dinosaur species 'Maiasaura'. During his time as the palaeontology consultant for the *Jurassic Park* films, Horner advised Steven Spielberg on how to make the portrayal of dinosaurs as realistic as possible. While he deems the cloning process pure fiction, this hasn't stopped Horner from trying to bring back the dinosaurs

How would a Jurassic Park need to be changed in real life?

If you really, seriously want to build a Jurassic Park and are not just making a movie, you want walls around the dinosaurs to keep them in. Reinforced concrete is going to work a lot better than electric fences, because electricity can go out. Electric fences were not a very good idea.

In reality, could any of the cloning processes seen in the film work?

We think we have found signals for DNA and that there might be tiny bits left, but not enough to use to make a dinosaur. We can get collagen and some dinosaur proteins, but not all the material we need. If we had the DNA, it would be ridiculous to put it in an ostrich egg. The thing to do would be to grow it in a test tube, because we have no idea how big the embryos of all dinosaurs are. Some dinosaur eggs are the size of ostrich eggs, but for a Tyrannosaur, we think they are a lot longer and they're bigger. It's like thinking about putting a human embryo inside a squirrel. If we're going to make a dinosaur, it's not going to be in the same way as *Jurassic Park*. That doesn't mean we can't make one. I actually have a laboratory where we are attempting to figure out how to make a dinosaur.

How are you trying to create a dinosaur?

It's called the dino-chicken project, and it's mostly based on genetic engineering. The idea is to use atavistic genes. They are basically ancestral genes, meaning that ancestral animals programmed certain features. For instance, occasionally children are born with extra vertebrae and form a low tail, which the doctor just picks off when the child is born. And every once in a while snakes are born with little appendages. Whales evolved from land animals, and occasionally they are born with extra limbs sticking out the side of themselves. These are atavistic genes. They were useful at one time, but through the course of evolution they have been turned off. Occasionally they are accidentally turned back on, and snakes get a set of legs.

> "We are attempting to figure out how to make a dinosaur"

I was hoping that some of the features of a dinosaur were atavistic in a bird. All bird species are related to one another, with one common ancestor – dinosaurs – so any bird should work. Chickens are the easiest thing to get eggs from, so I built a laboratory, hired some geneticists and developmental biologists and started seeing if we could find some of these potential atavistic genes.

Why did you start this project?

I'd like to have a pet dinosaur. Wouldn't everybody like to have a pet dinosaur? I have a pet bird, but that's the closest I can get right now. When I started the project, everybody thought it was just crazy. But then, after a little while, other laboratories started working on it, like Yale University and McGill University, and they started finding some atavistic genes. We've been working on the tail, mostly, because that seems to be the hardest part.

Is your method working?

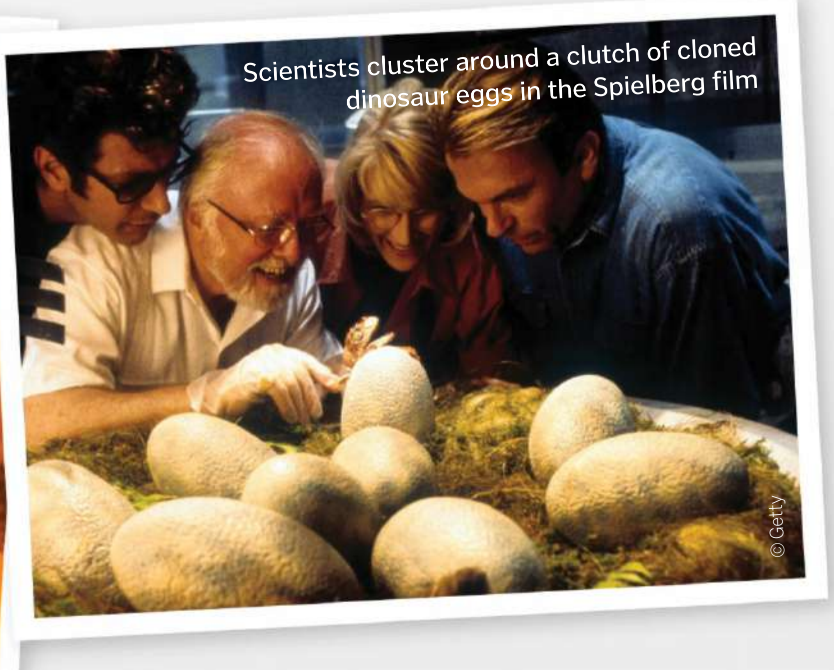
We discovered that the reduction of the tail from long-tail dinosaur to a short-tail bird is not an atavistic gene. We are trying to figure out how the tail actually works and reverse the process that formed the short tail. Other laboratories have looked at the face, teeth, arms and hands. I think we can do pretty much all the rest of the body. We have the potential of making an animal that has a dinosaur-like head, probably with teeth in it, and we certainly have the capability of reversing the wings to make arms and hands. We know we can do that, but right now we're just trying to fix the tail.

If you succeed, would you make something similar to a Jurassic Park?

That's a whole different thing. People always say, 'where are you going to put these dinosaurs when you make them', and I always say that many thousands of years ago we started with wolves, and now we have Chihuahuas. Dogs are basically wolves, and we don't really have to contain them. I wouldn't expect dino-chickens to be the same as the dinosaurs in *Jurassic Park*. They're going to be domestic animals that we don't have to worry about. If you were cloning a real Tyrannosaur, you would have to worry about containing them. Dogs and cats were wild, but now we don't have to contain them – not to the point of making a park anyway.

A prehistoric insect preserved in amber

© Alamy

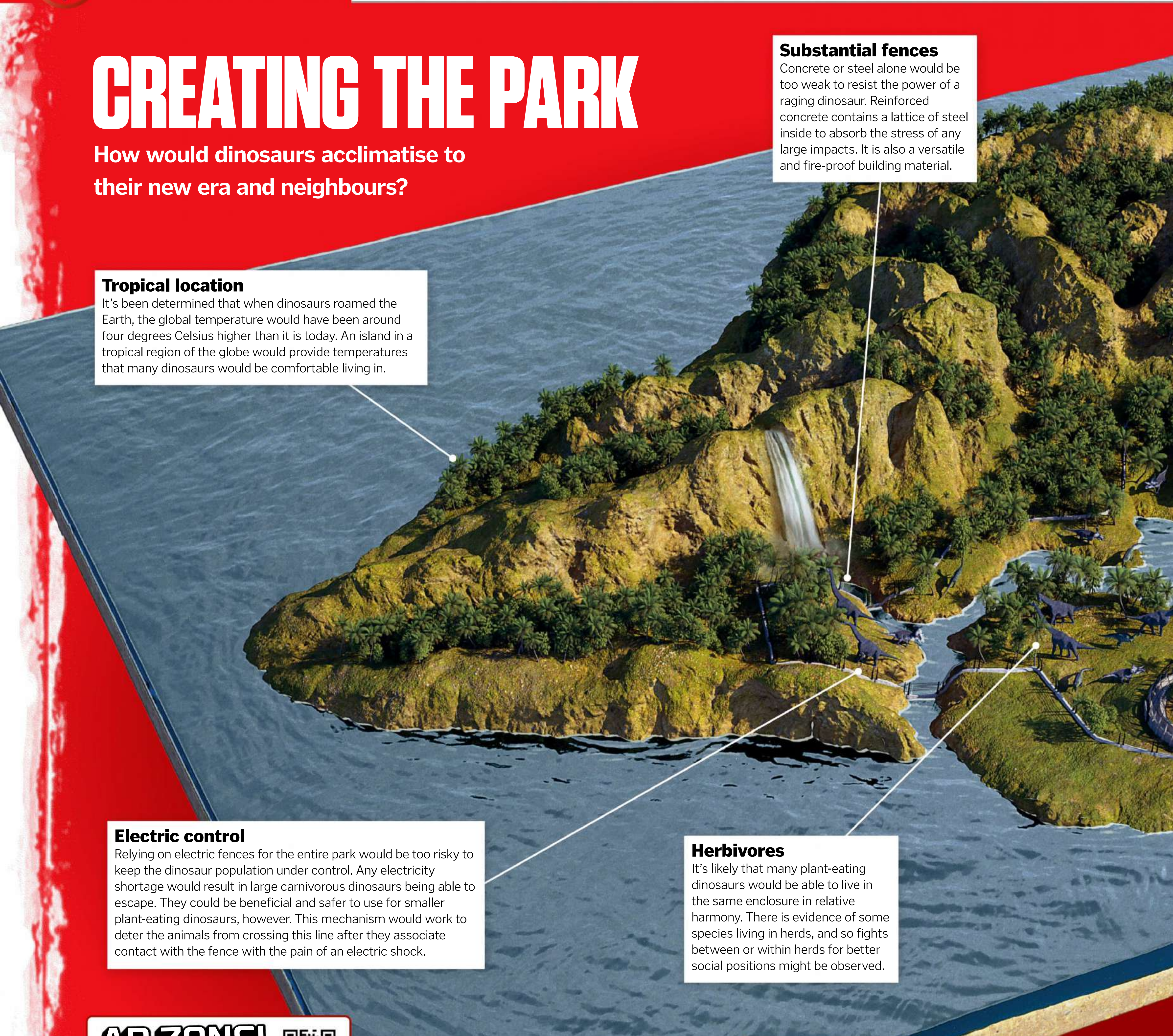


Scientists cluster around a clutch of cloned dinosaur eggs in the Spielberg film

© Getty

CREATING THE PARK

How would dinosaurs acclimatise to their new era and neighbours?



Substantial fences

Concrete or steel alone would be too weak to resist the power of a raging dinosaur. Reinforced concrete contains a lattice of steel inside to absorb the stress of any large impacts. It is also a versatile and fire-proof building material.

Tropical location

It's been determined that when dinosaurs roamed the Earth, the global temperature would have been around four degrees Celsius higher than it is today. An island in a tropical region of the globe would provide temperatures that many dinosaurs would be comfortable living in.

Electric control

Relying on electric fences for the entire park would be too risky to keep the dinosaur population under control. Any electricity shortage would result in large carnivorous dinosaurs being able to escape. They could be beneficial and safer to use for smaller plant-eating dinosaurs, however. This mechanism would work to deter the animals from crossing this line after they associate contact with the fence with the pain of an electric shock.

Herbivores

It's likely that many plant-eating dinosaurs would be able to live in the same enclosure in relative harmony. There is evidence of some species living in herds, and so fights between or within herds for better social positions might be observed.

AR ZONE!
SCAN HERE

Living with dinosaurs

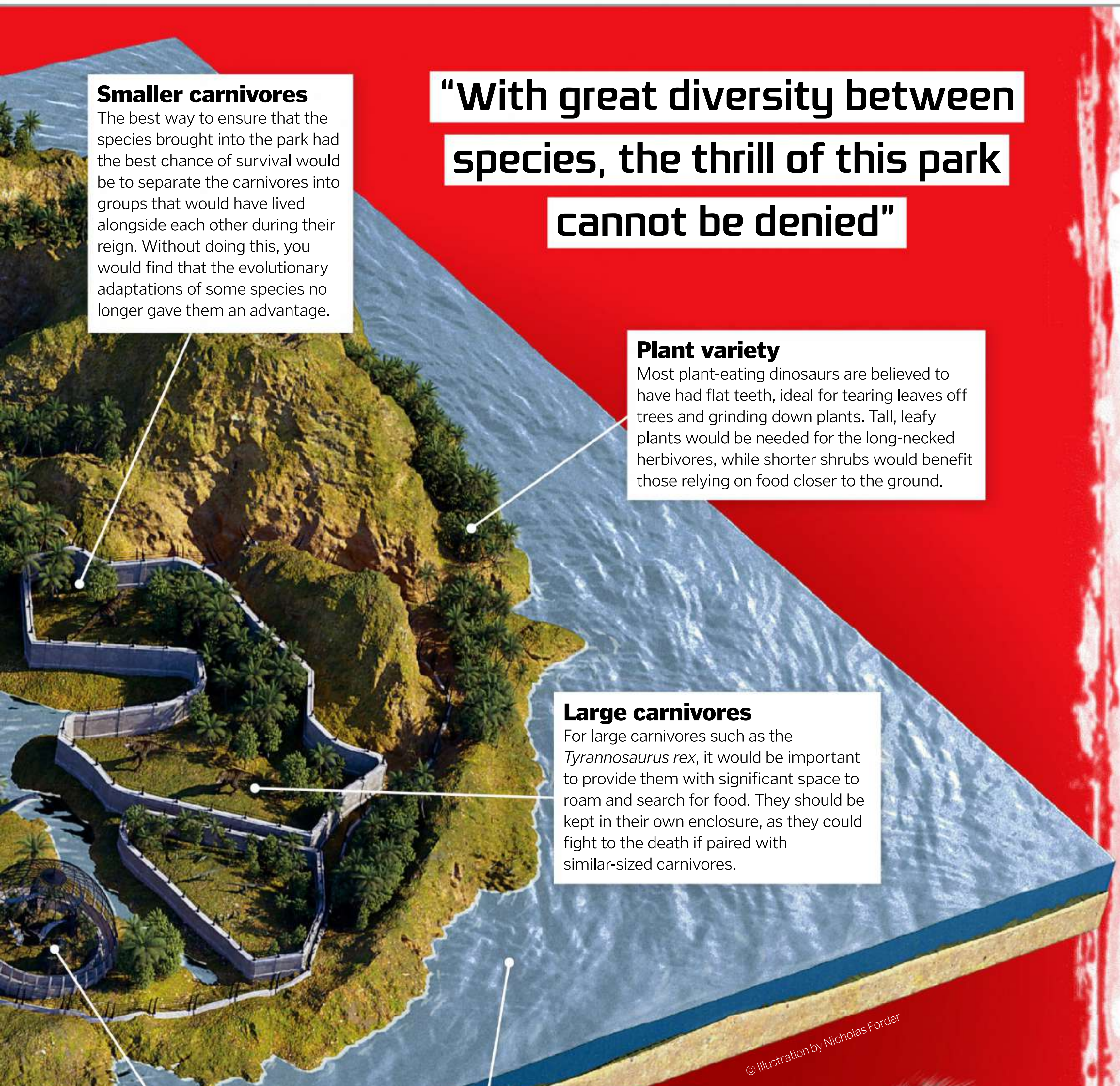
If dinosaurs hadn't gone extinct, humans are unlikely to have been able to evolve. During the 150 million years that dinosaurs existed, mammals lived alongside them, but these animals were nocturnal and lived in burrows. This suggests that this was the only way for mammals to thrive alongside dinosaurs, emerging mainly at night to hunt. Because our lives are completely separate to that of dinosaurs, there's no way of knowing what would happen if dinosaurs were to live on the same land as us.

By observing human behaviour with today's large predators, it seems unlikely that the two species would live naturally together. Humans take up so much space on the planet that introducing predators like dinosaurs outside of captivity would result in a battle for land.

© Alamy

Introducing meat-eating dinosaurs to Earth would give humans a natural predator

DID YOU KNOW? *Dinosaurs survived on Earth for over 150 million years, while great apes have lived for 6 million years so far*



© Illustration by Nicholas Forder

Smaller carnivores
The best way to ensure that the species brought into the park had the best chance of survival would be to separate the carnivores into groups that would have lived alongside each other during their reign. Without doing this, you would find that the evolutionary adaptations of some species no longer gave them an advantage.

> "With great diversity between species, the thrill of this park cannot be denied"

Plant variety
Most plant-eating dinosaurs are believed to have had flat teeth, ideal for tearing leaves off trees and grinding down plants. Tall, leafy plants would be needed for the long-necked herbivores, while shorter shrubs would benefit those relying on food closer to the ground.

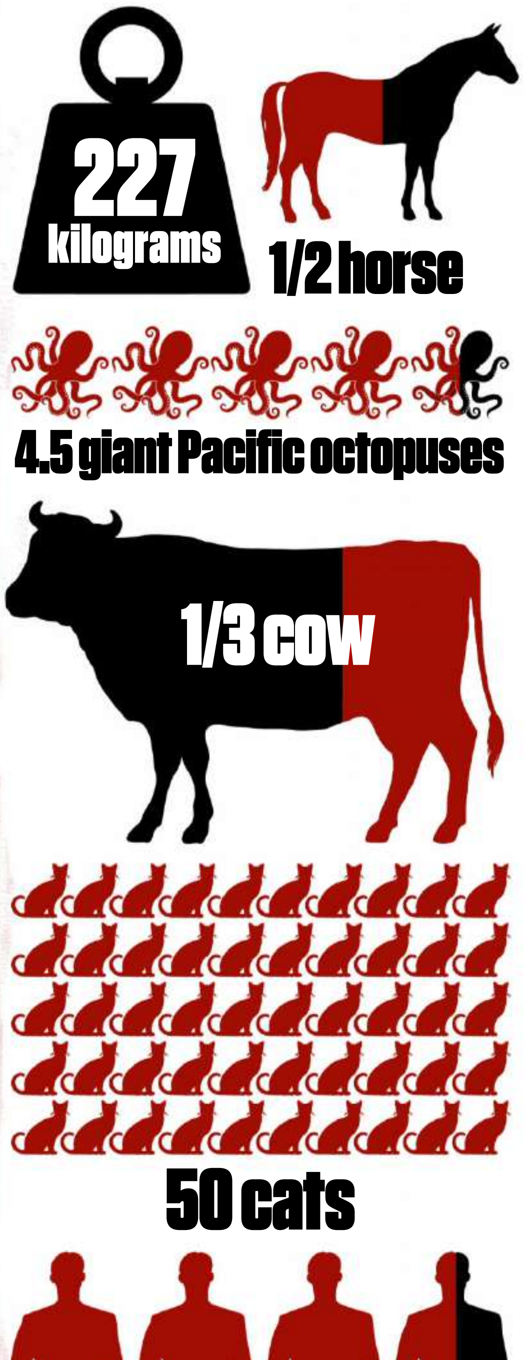
Large carnivores
For large carnivores such as the *Tyrannosaurus rex*, it would be important to provide them with significant space to roam and search for food. They should be kept in their own enclosure, as they could fight to the death if paired with similar-sized carnivores.

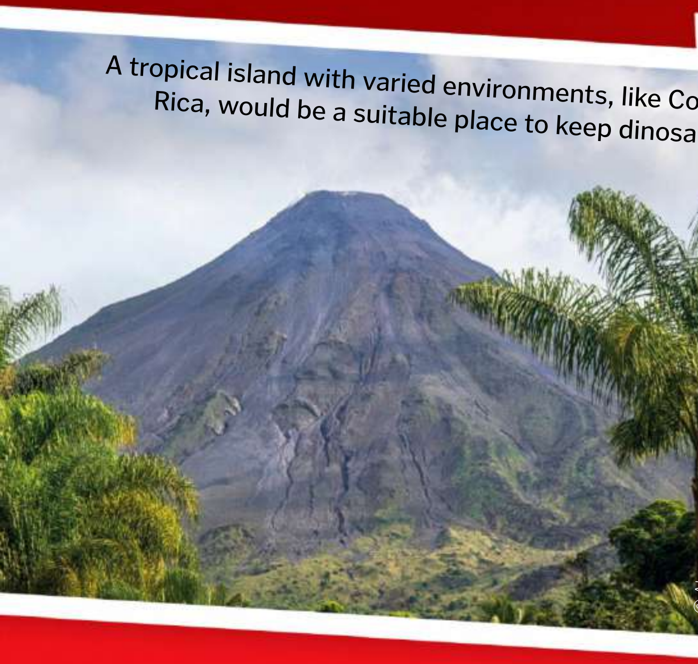
Atmosphere adaption
Some studies of air trapped in amber show that its composition during the Cretaceous Period may have been 35 per cent oxygen, as opposed to today's 21 per cent. However, during the dinosaurs' extended time on the planet, this number is believed to have varied substantially. Some species would be better suited to our air than others.

Aviary
With wingspans over seven metres, species such as the pteranodon could not be contained on an open island. In order to limit the movement of flying species, a large, dome-shaped enclosure would be needed.

A BITE TO EAT

How much food could an adult *T. rex* consume in one mouthful?



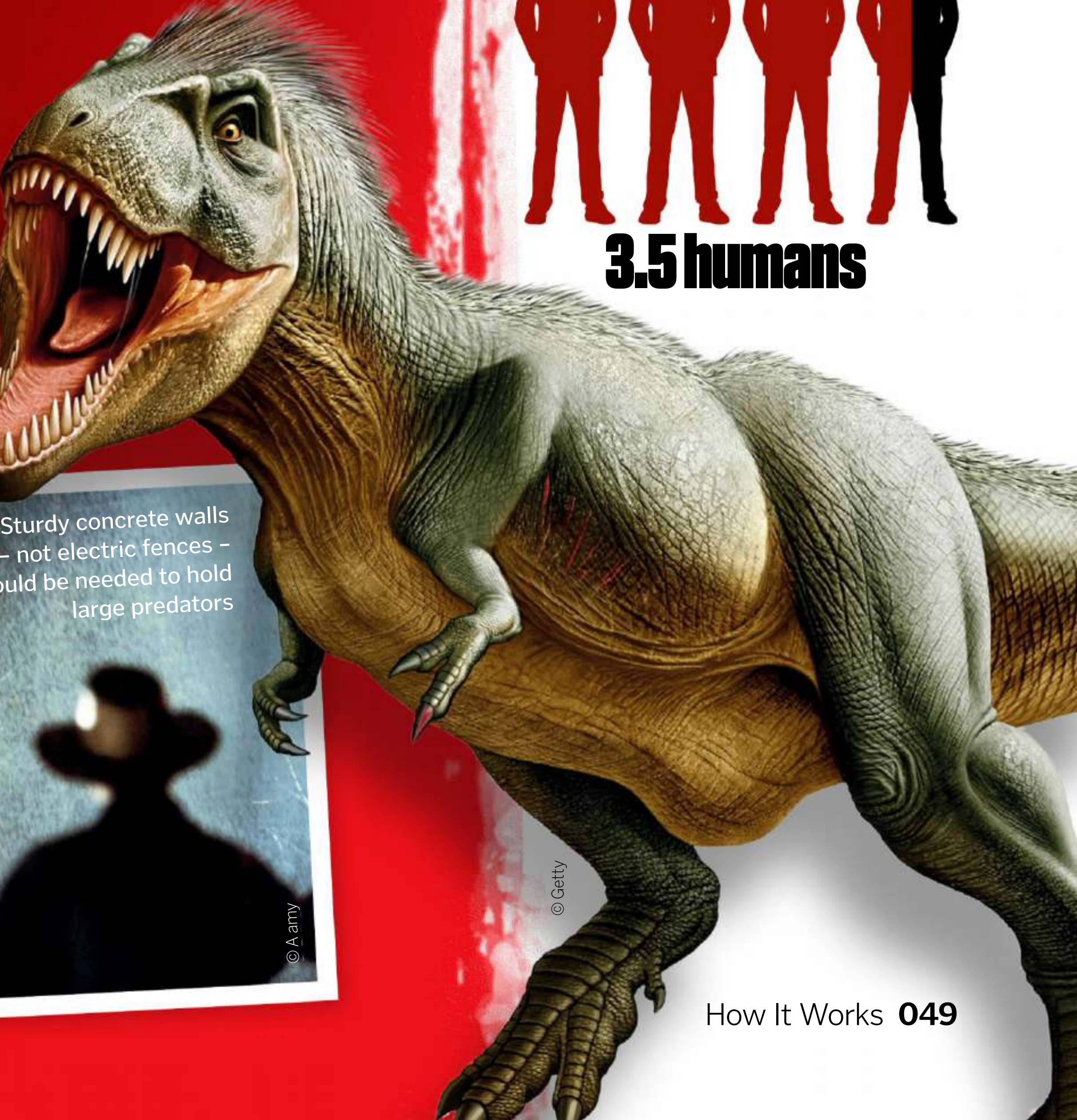


A tropical island with varied environments, like Costa Rica, would be a suitable place to keep dinosaurs

© Alamy

Sturdy concrete walls – not electric fences – would be needed to hold large predators

© Alamy



© Getty

Wave power

Generating electricity using the motion of the ocean

Words by **Ailsa Harvey**

Finding renewable energy sources has become more essential than ever as scientists seek solutions to the climate crisis and better ways to supply our expanding energy needs. Two of the most popular natural resources used to generate electricity are the Sun and wind. However, energy from the ocean is a more consistent source.

Water covers more than two-thirds of our planet's surface, and its natural motion is unceasing. While solar power is limited to daylight hours and wind power is dictated by the weather, wave power remains constant. The strength and frequency of waves can vary, but the sea is never totally still.

But how is it possible to create electricity from this motion? The energy-converting devices responsible vary in their design. Some are relatively small, but float on the surface of the ocean in large numbers. As these move with the fluctuations of the water in wavy conditions, the energy creating this movement is harnessed using magnets.

Other devices have a flat panel design that can be fully immersed in the water. With a large surface area, these devices move with the direction of the waves like a pendulum, tilting one way then the other. One crucial component inside these devices is the hydraulic ram, which pumps high-pressure fluid through the hydraulic motors. The movement of the hydraulic motors causes the electrical generators to produce an electric current.

This wave-energy buoy was placed off the coast of Kane'ohe Bay in Hawaii to provide energy for Honolulu

© Alamy

The world's largest wave farm

Aquamarine Power is a Scottish marine engineering company set to build the world's largest wave energy farm. Having been approved by the Scottish Government, as well as the local council, the site is due to be installed off the Isle of Lewis and has the potential to power around 30,000 homes when complete.

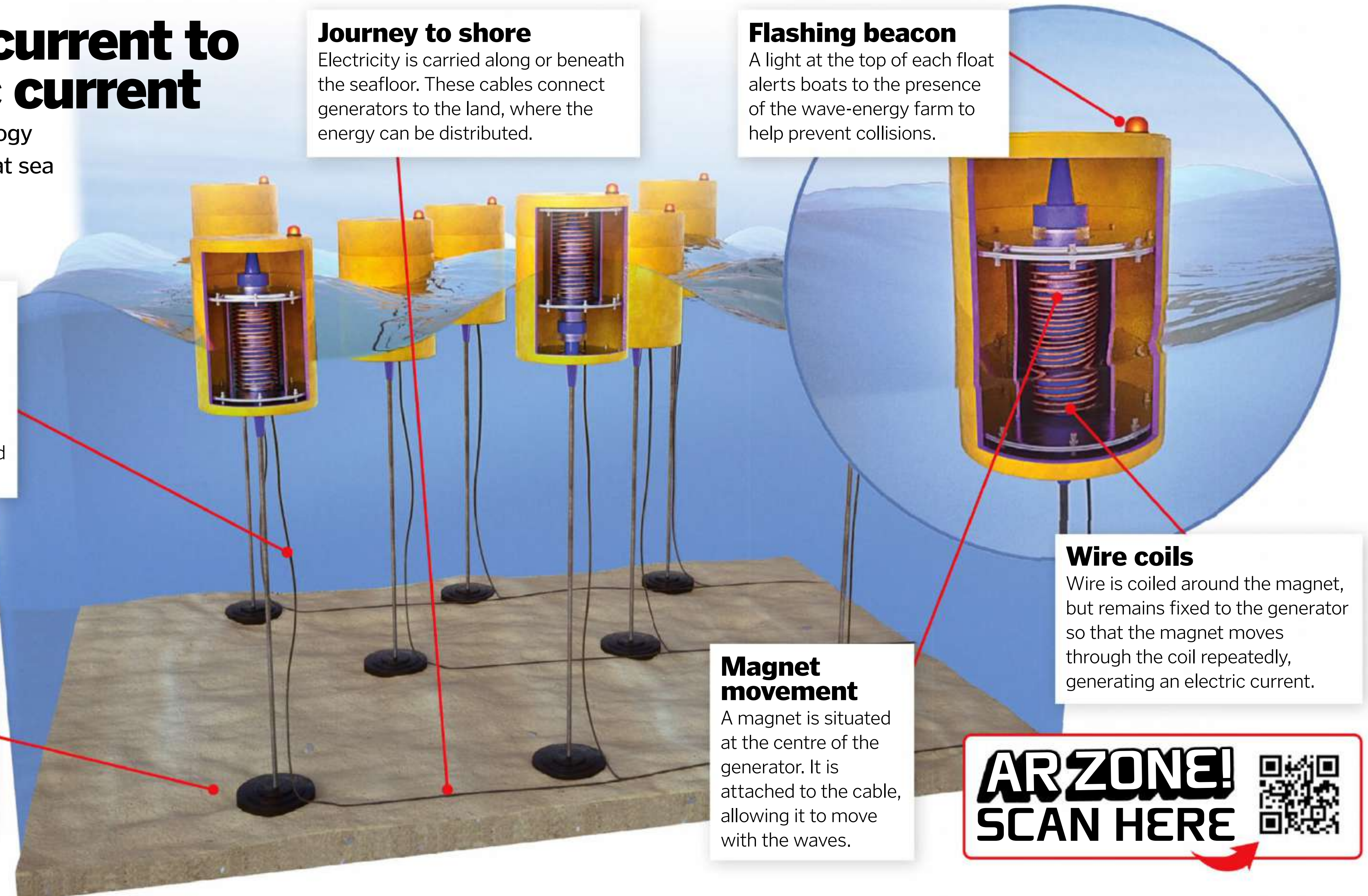
The company aims to set up between 40 and 50 of its energy-producing devices. Called Oyster, these will be bolted to the seafloor. Provided it's installed in water at least 10 to 12 metres deep, Oyster generates electricity through the movement of a vertically standing panel. As the waves move horizontally, panels are pushed, causing them to flap backwards and forwards. This is the movement that will be converted into electrical energy by a built-in generator.

© Alamy

The yellow-topped component of Aquamarine Power's Oyster device will face upwards from the seafloor when unfolded from the base

Ocean current to electric current

Inside the technology producing power at sea


Journey to shore
Electricity is carried along or beneath the seafloor. These cables connect generators to the land, where the energy can be distributed.

Flashing beacon
A light at the top of each float alerts boats to the presence of the wave-energy farm to help prevent collisions.

Cable connection
A cable connects the buoy to the seabed. As its float moves with the water, the cable is stretched and moved up and down.

Wire coils
Wire is coiled around the magnet, but remains fixed to the generator so that the magnet moves through the coil repeatedly, generating an electric current.

Secure anchor
The device is securely bolted to the seafloor so that it remains effective in stormy conditions.

Magnet movement
A magnet is situated at the centre of the generator. It is attached to the cable, allowing it to move with the waves.

AR ZONE! SCAN HERE

© Illustration by Nicholas Forder

FREE

2 FREE eBOOKS FOR EVERY READER!

Grab yourself two fascinating, fact-packed **How It Works** specials for your digital device. Simply use the link below or scan the QR code to download

300+ PAGES WORTH £25

NEW
DISCOVER HOW HUMANITY REACHED BEYOND EARTH
SPACE
EXPLORATION
MARS
EVERYTHING YOU NEED TO KNOW ABOUT THE RED PLANET
World's Greatest
NATIONAL PARKS
DISCOVER THE MOST STUNNING LANDSCAPES ON EARTH
OVER 70 OF THE WORLD'S MOST INCREDIBLE PARKS
The Lake District
Enjoy the idyllic scenery of the UK's most popular park
The First National Park
Why establishing Yellowstone was "America's best idea"
EXPLORE UNIQUE ENVIRONMENTS
FIND A WILDERNESS ADVENTURE
RECONNECT WITH NATURE
ENCOUNTER A WORLD OF WILDLIFE

+

2 DIGITAL POSTERS

5 SMARTPHONE WALLPAPERS

The Earth's structure
Prehistoric era dinosaurs of Niger
DRAWN TO SCALE
HOW IT WORKS

Space Exploration

Rewind the clock to the 1950s and relive the first brave forays into space exploration with the likes of Sputnik before moving into the Space Age. Look back on iconic white-knuckle missions such as the Apollo 11 Moon landing, with special insight from Buzz Aldrin. Uncover some of the universe's most beautiful sights, and look at the intrepid Voyager probes as they journey further into interstellar space. Examine the technology that drives space exploration, as well as our fascination with Mars.

World's Greatest National Parks

Ever since Yellowstone National Park was established in 1872, countries all over the world have followed in America's footsteps. Today there are over 4,000 national parks across the globe, protecting a wide variety of landscapes. These unspoiled areas make fantastic travel locations. Whether you want to camp in the Lake District, hike through the chasm of the Grand Canyon, bungee jump by Victoria Falls or cruise along the tranquil Li Jiang River, they're ideal destinations for nature lovers of all ages.

CLAIM YOURS NOW

eBooks
bit.ly/3vg1WaT

Posters and wallpapers
bit.ly/3n9MGcz

Meet the ski car

This one-off vehicle shows us what's possible when you put a car on skates

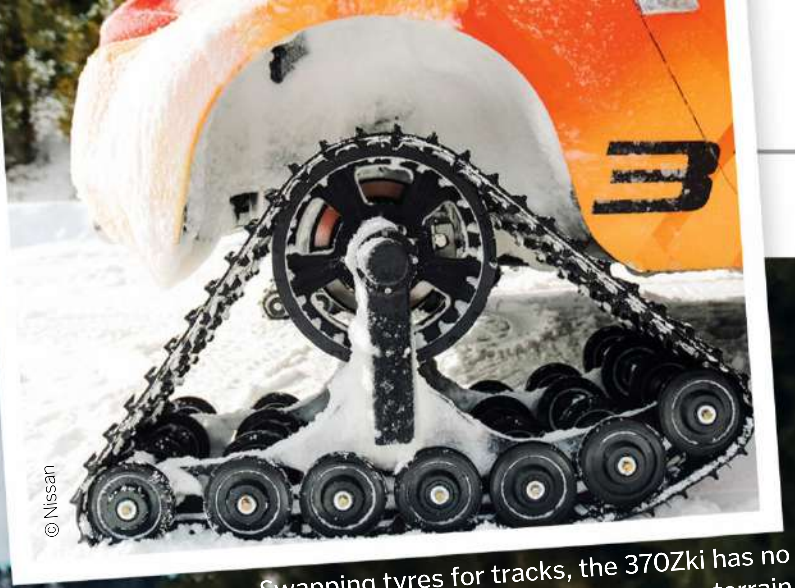
After hurtling through the Wyoming snow, the Nissan 370Zki made its ski slope debut at the 2018 Chicago Auto Show. Pronounced '370-ski', it showed the world what happens when you combine the power of a sports car with the agility of a snowmobile.

The base vehicle for the 370Zki is one of Nissan's legacy Z models, first making an appearance as the 240Z in 1969. The Z model has had several upgrades since, including this one-off winter reimagining. Nissan used a factory stock 370Z Roadster and ditched the wheels for a pair of skis and rear tracks.

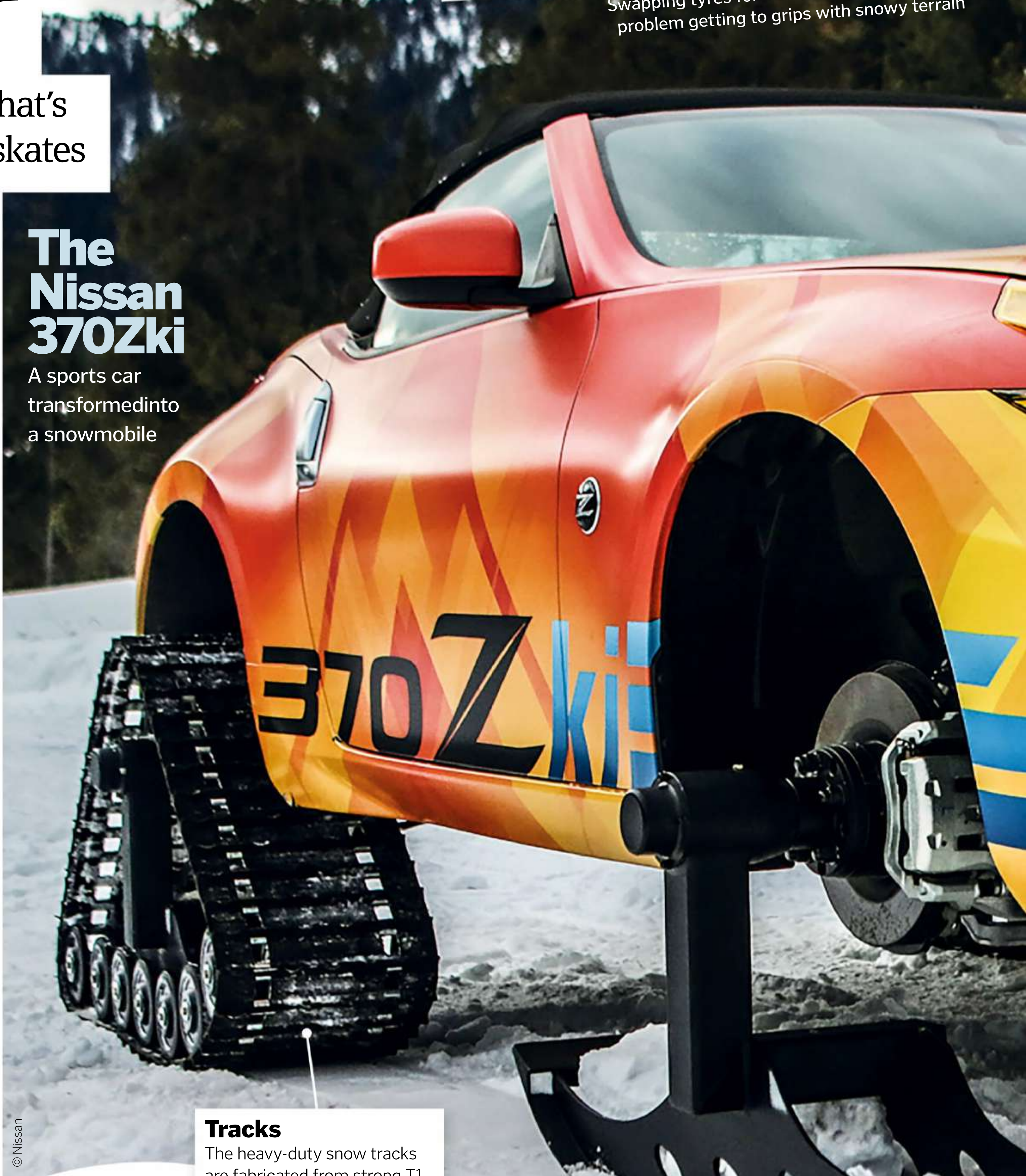
To mount the new additions, the entire drivetrain, which connects the driveshaft to the car's wheels, was removed and replaced with a custom system. The original braking system for the Roadster remained, but the exhaust system was rerouted to fit under the vehicle. Also, the rear wheel wells were modified to accommodate its massive new snow tracks, which each measure around a metre long. At the front of the 370Zki, tyres were traded in for a pair of custom steerable skis, which were provided by American Track Truck, Inc.

This isn't the first time Nissan has given one of its cars a winter makeover. Back in 2016 the car manufacturer swapped out all four tyres of a Nissan Rogue for the same triangular tracks on the 370Zki. The vehicle was showcased at the 2016 Montreal International Auto Show, zipping around snowscapes at around 62 miles per hour.

Unfortunately, the Chicago Motor Show is where the journey of the Nissan 370Zki began and ended. But there have been some supercar owners who may have taken inspiration from Nissan's creation and have adapted their own vehicles with snow tracks, such as a Tesla Model 3 in 2020 and Lamborghini Aventador earlier this year.


© Nissan

Swapping tyres for tracks, the 370Zki has no problem getting to grips with snowy terrain



The Nissan 370Zki

A sports car transformedinto a snowmobile

© Nissan

Tracks
The heavy-duty snow tracks are fabricated from strong T1 steel and weigh around 80 kilograms each.

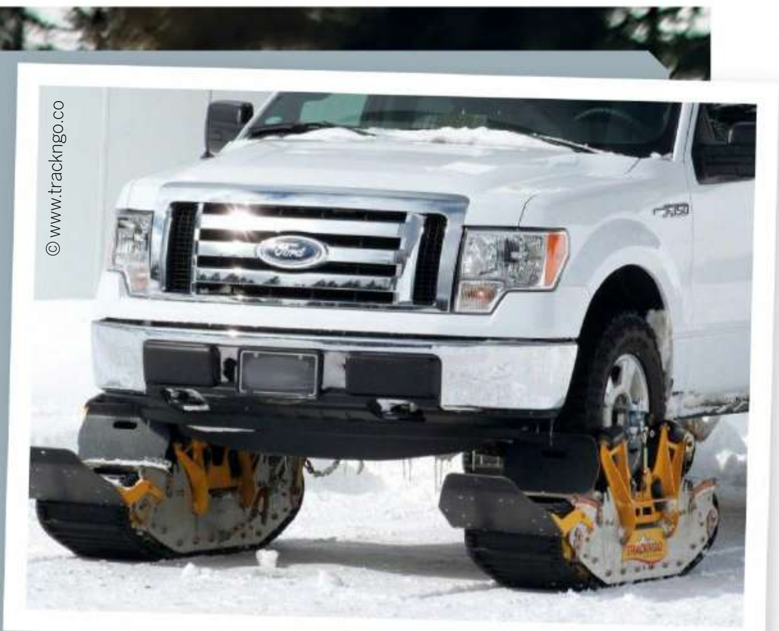
Skis
The front skis are custom built to match the height of the rear track and measure 1.4 metres to support the vehicle.

© Nissan

The 370Zki was cruising along the slopes of Wyoming with ease back in 2018

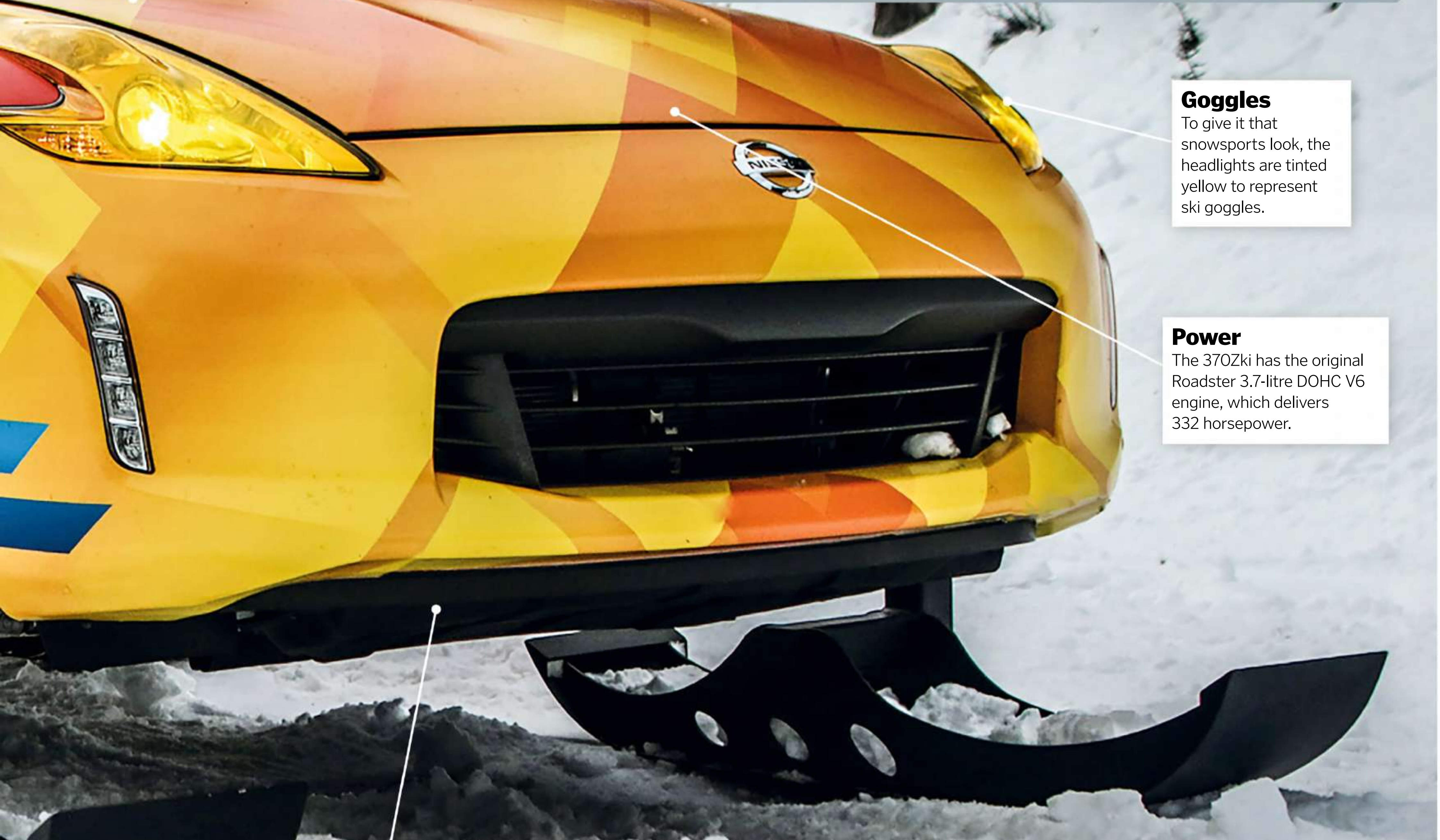
Put your skates on

Nissan isn't the only one having fun transforming vehicles into snow machines. Innovative systems such as Track N Go allow drivers to dress their vehicles for winter. Much like stepping into an ice skate, vehicles can simply drive into the Track N Go system via a small ramp and be secured in place. As the vehicle's wheels turn, the tracks below will move with them. The system is also pneumatically mounted, which means when the track hits an obstacle, such as a mound of snow, the impact is absorbed and the vehicle can easily manoeuvre around it. These tracks allow vehicles to reach up to around 25 miles per hour through snow, or 37 miles per hour on hard surfaces. Systems like this have allowed emergency and rescue services to reach snow-laden areas.



© www.trackngo.co

It only takes 15 minutes for a vehicle to slip on its snow tracks



Body
A Nissan 370Z Roadster cloth-roof convertible was used as the base vehicle.

Goggles
To give it that snowsports look, the headlights are tinted yellow to represent ski goggles.

Power
The 370Zki has the original Roadster 3.7-litre DOHC V6 engine, which delivers 332 horsepower.

Height
To accommodate the new snow tracks, the entire vehicle is raised around seven centimetres from its original height.

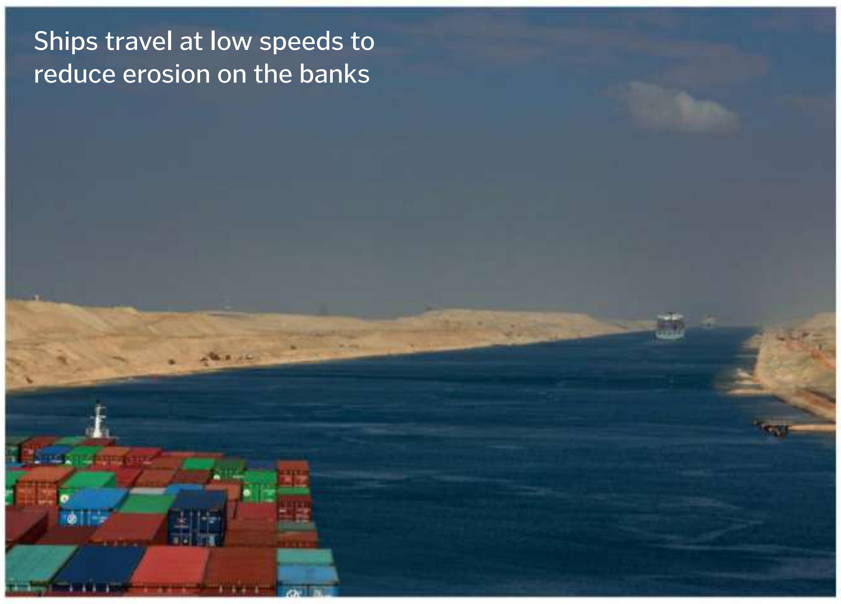
© Nissan

In 2016 Nissan transformed one of its Rogue model vehicles into a heavy-duty snowmobile

Why we need the Suez Canal

Humans changed Earth's geography to create this long waterway through Egypt, but what happens when the route is obstructed?

Words by **Ailsa Harvey**



Ships travel at low speeds to reduce erosion on the banks

© Alamy

For the seafarers of the world, land is an obstacle to navigate. But this doesn't always mean taking the long route around it to get from A to B. In the 1800s, a faster path was created for trade between continents. The result was the Suez Canal, a human-built waterway through Egypt.

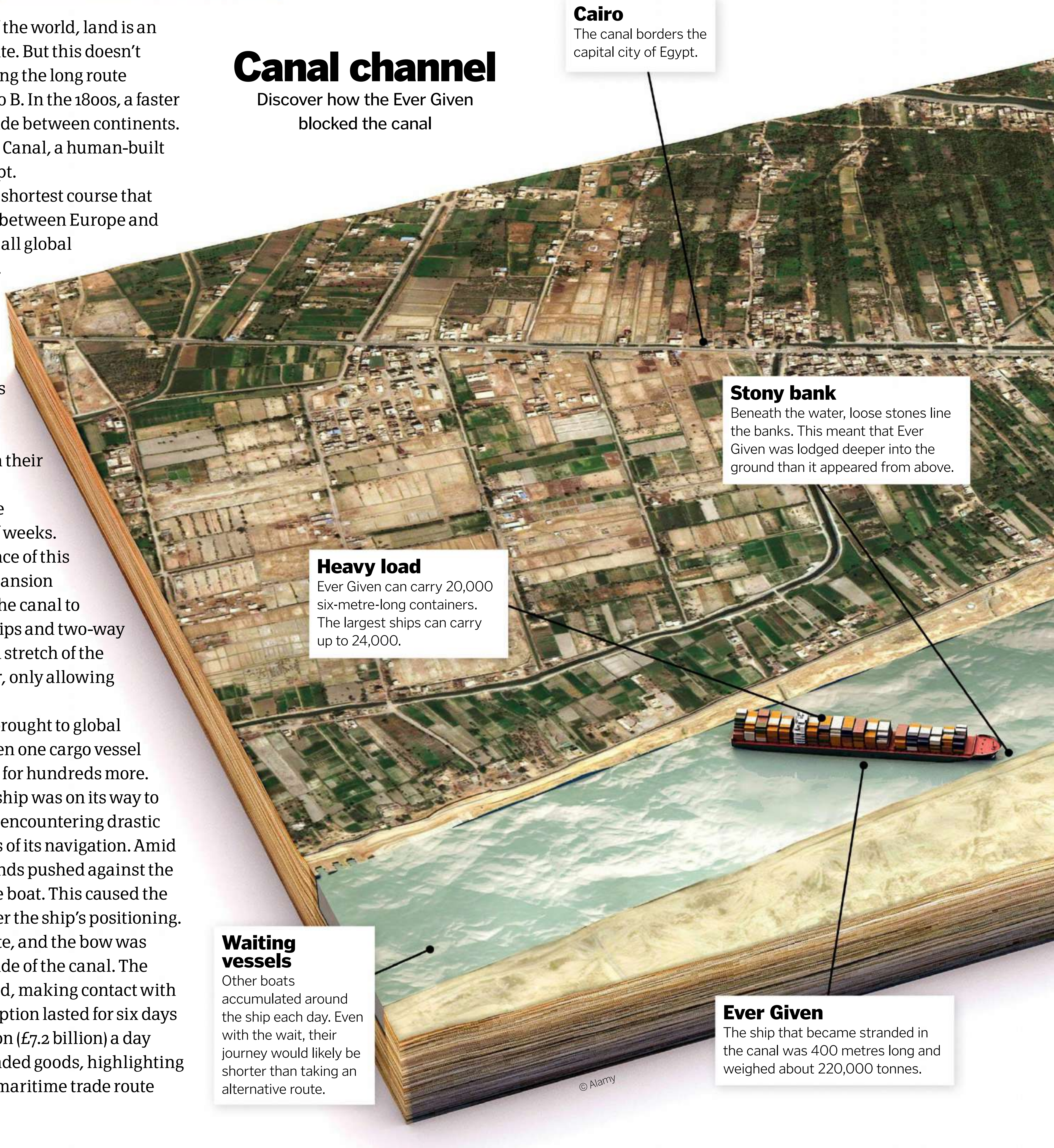
This canal is now the shortest course that ships can take to travel between Europe and Asia, with 12 per cent of all global trade sailing through it. More than 50 vessels embark on the journey along this canal each day, which can take between 12 and 16 hours from end to end. The shortcut has allowed trading ships to shorten their delivery of a variety of products between some countries by a matter of weeks.

As the huge importance of this canal was realised, expansion projects have allowed the canal to accommodate larger ships and two-way traffic. But the southern stretch of the canal is much narrower, only allowing one-way traffic.

The Suez Canal was brought to global attention in March, when one cargo vessel caused major problems for hundreds more. Called Ever Given, this ship was on its way to Rotterdam from China, encountering drastic difficulties during parts of its navigation. Amid a sandstorm, strong winds pushed against the containers on board the boat. This caused the pilots to lose control over the ship's positioning. The stern began to rotate, and the bow was forced too close to the side of the canal. The vessel became grounded, making contact with the shallows. The disruption lasted for six days and prevented $10 billion (£7.2 billion) a day being made through traded goods, highlighting just how essential this maritime trade route really is.

Canal channel

Discover how the Ever Given blocked the canal



Cairo
The canal borders the capital city of Egypt.

Stony bank
Beneath the water, loose stones line the banks. This meant that Ever Given was lodged deeper into the ground than it appeared from above.

Heavy load
Ever Given can carry 20,000 six-metre-long containers. The largest ships can carry up to 24,000.

Waiting vessels
Other boats accumulated around the ship each day. Even with the wait, their journey would likely be shorter than taking an alternative route.

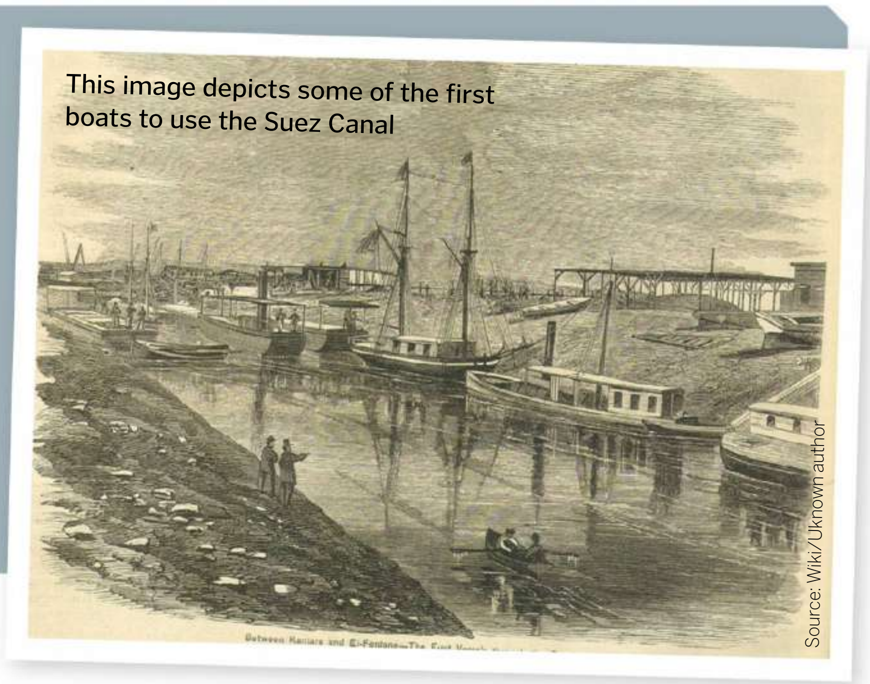
Ever Given
The ship that became stranded in the canal was 400 metres long and weighed about 220,000 tonnes.

© Alamy

Sailing through history

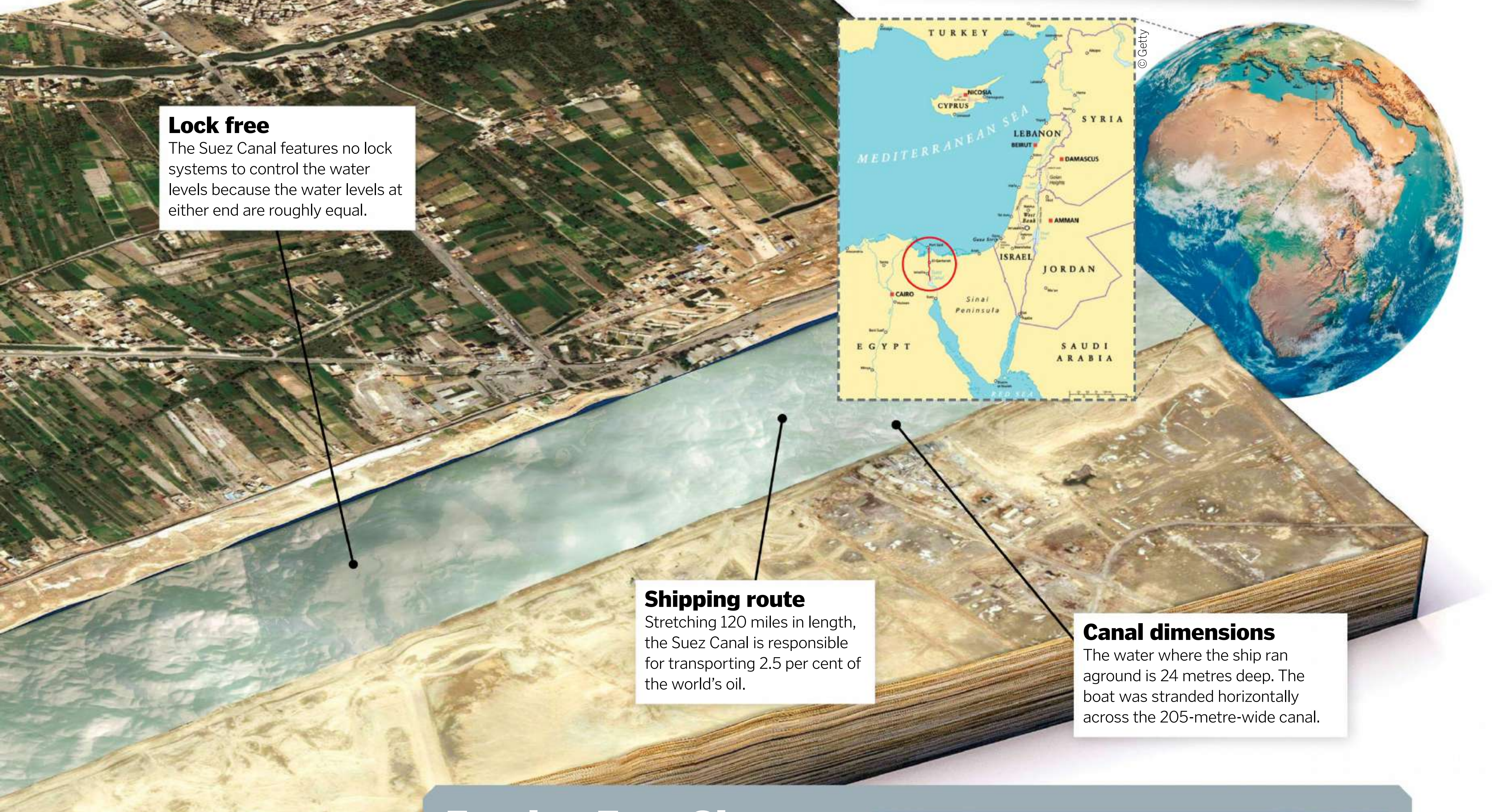
The Suez Canal first opened in 1869 after workers spent a decade building it. Its original purpose was largely the same as today – a convenient passage between Europe and Asia via the Mediterranean. Before this, any shipping between these continents would require boats to navigate around the African cape, adding 6,000 miles to the journey.

When the passage first opened, the canal was just 22 metres wide at the bottom, and between 61 and 91 metres wide at the surface. This limited the number of ships which could travel through, and during its first full year of operation fewer than 500 ships took the route. After World War II, the Egyptian government claimed ownership over the canal and limited which ships could pass through it. But today ships from anywhere in the world are permitted to travel through the Suez Canal.



This image depicts some of the first boats to use the Suez Canal

Source: Wiki/Uknown author



© Getty

Lock free
The Suez Canal features no lock systems to control the water levels because the water levels at either end are roughly equal.

Shipping route
Stretching 120 miles in length, the Suez Canal is responsible for transporting 2.5 per cent of the world's oil.

Canal dimensions
The water where the ship ran aground is 24 metres deep. The boat was stranded horizontally across the 205-metre-wide canal.

Sinai Peninsula
The canal was dug out where the land between seas was narrower. After its completion, the Sinai Peninsula became separated from the rest of Egypt.

Freeing Ever Given

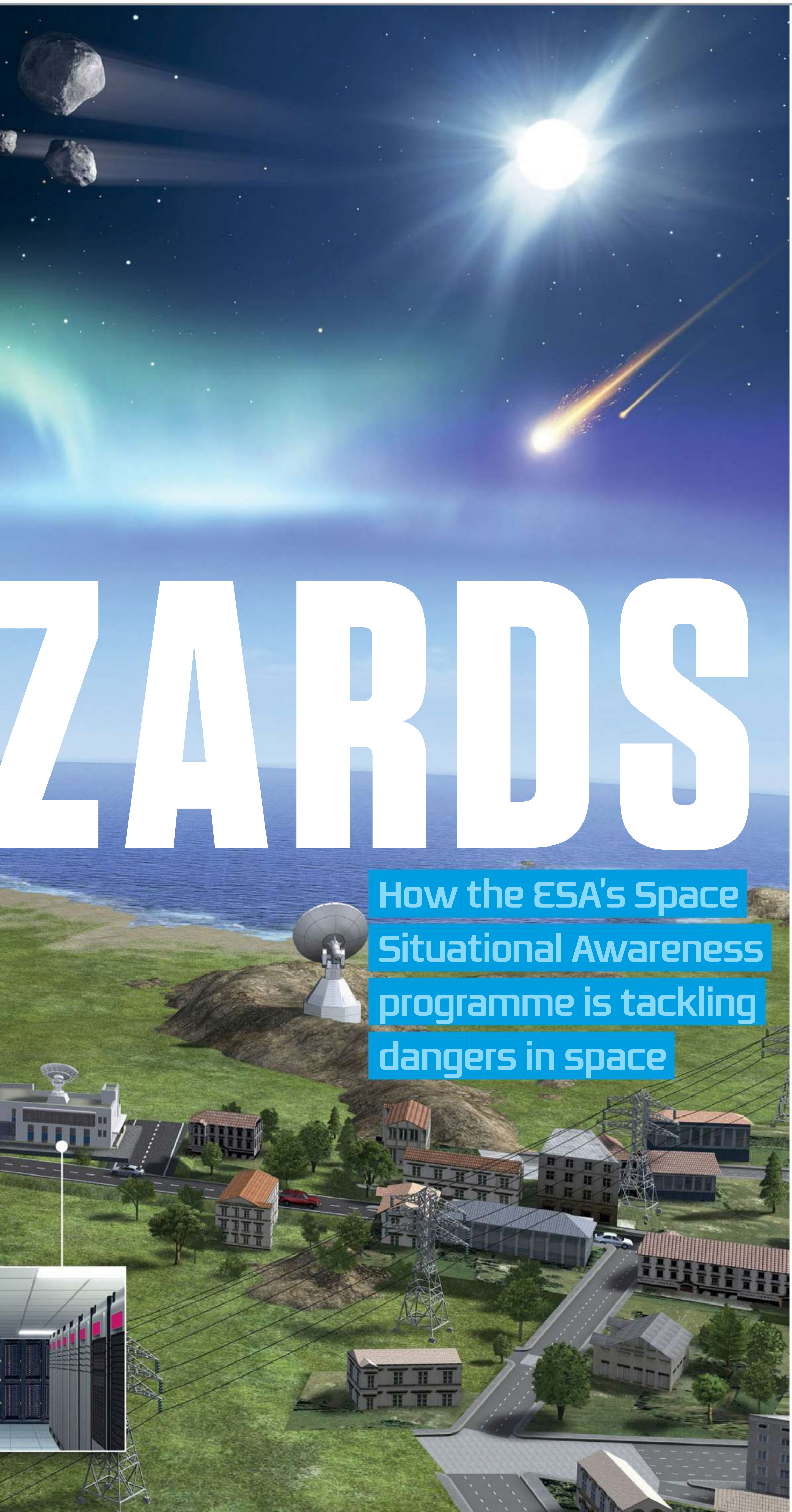
The rescue operation to free the ship took six days, but eventually the vessel was shifted, and the Suez Canal was once more open for business on 29 March. In order to refloat the boat, 30,000 cubic metres of sand had to be removed from around the vessel. This included sand along the shore as well as underwater sediment from beneath the wedged boat. A large dredger pipe was used to move this sediment along the canal and away from the area of operation. This long pipe uses suction to force sand along it. While this helped to float the ship, the pushing strength of 14 smaller tugboats was used to reposition it so that it no longer spanned the width of the canal.

Ever Given is pulled along the canal by tugboats after being dislodged from the sand

© Alamy

DETECTING
SPACE HA

DID YOU KNOW? *The UK remains an active member of the ESA, which is a separate entity from the European Union*



© ESA

ZARDS

How the ESA's Space Situational Awareness programme is tackling dangers in space

Words by **Andrew May**

Threats from outer space: it sounds like science fiction, but at some level Earth has always been vulnerable to them. Think of the giant asteroid that wiped out the dinosaurs 66 million years ago. Fortunately such occurrences are extremely rare, but there are other natural phenomena – in the form of solar storms – that can strike from space much more frequently.

These have little effect on living things, but they can play havoc with the electronic systems we increasingly depend on, with satellite-based technology in particular at risk of being affected. To make matters worse, the proliferation of the latter has created a new space hazard of its own in the form of orbiting debris with the potential to destroy other satellites.

Numerous organisations around the world have been set up to address these threats, but it's usually done in a piecemeal fashion. In America, for example, the tracking of space debris is carried out by the US Space Force, the monitoring of 'space weather' is coordinated by the National Oceanic and Atmospheric Administration and the search for potentially hazardous asteroids is the job of NASA's grandly named Planetary Defense Coordination Office. The European Space Agency (ESA), on the other hand, has adopted a unified approach to all these activities under the umbrella of its Space Situational Awareness programme. Set up in 2009, this is divided into three segments covering space weather, near-Earth objects and space surveillance and tracking.

The emphasis in all three areas is on the detection and tracking of potential threats. As long as these are known in advance, appropriate action can be taken to minimise danger. The projected impact site of an asteroid can be evacuated, for example, or a satellite on a collision course with a piece of space debris can be moved to a different orbit.

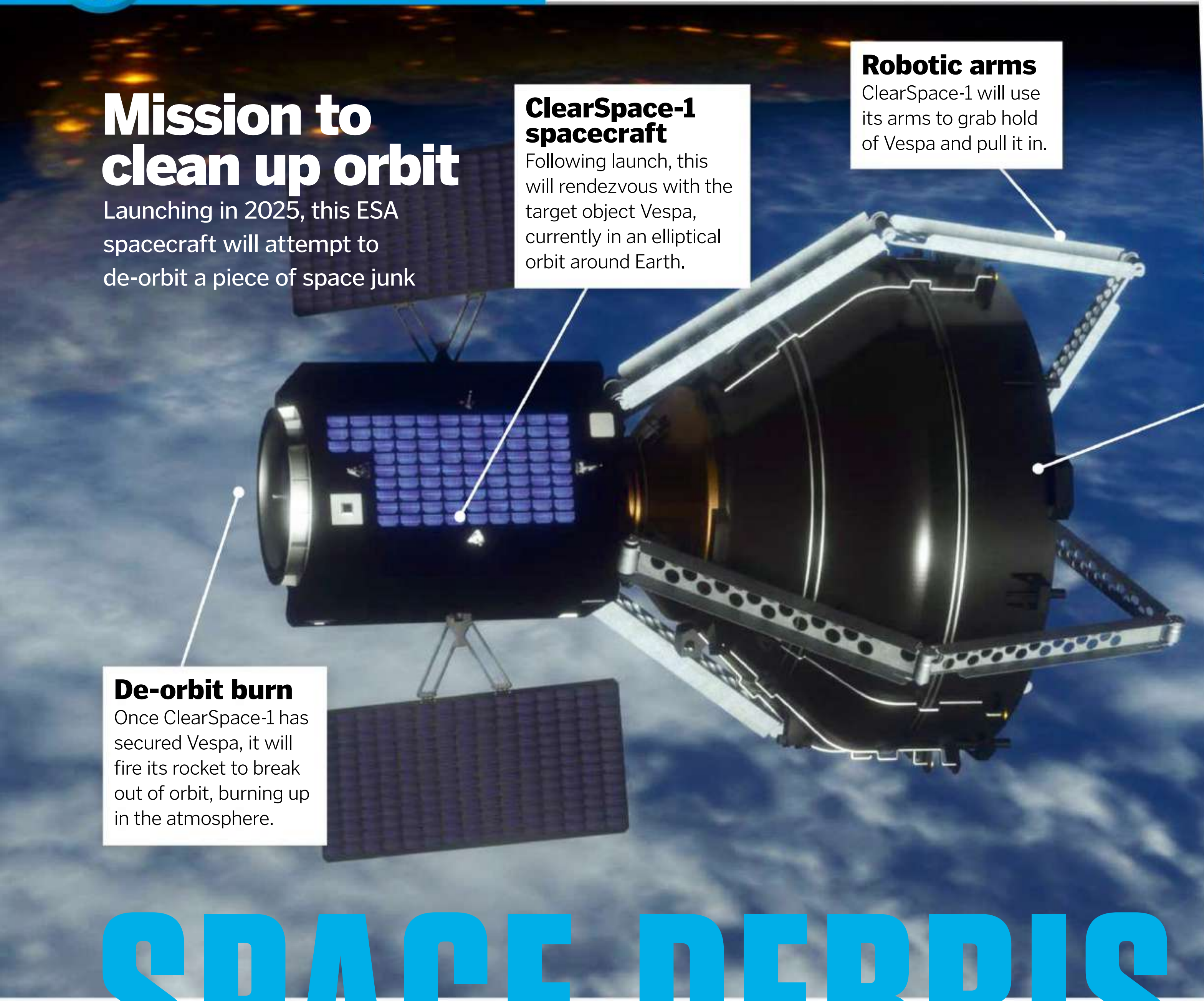
© ESA

Fuel left in old rocket stages can explode, creating a cloud of space debris

AR ZONE!

Mission to clean up orbit

Launching in 2025, this ESA spacecraft will attempt to de-orbit a piece of space junk



ClearSpace-1 spacecraft
Following launch, this will rendezvous with the target object Vespa, currently in an elliptical orbit around Earth.

Robotic arms
ClearSpace-1 will use its arms to grab hold of Vespa and pull it in.

Vespa payload adapter
Weighing 100 kilograms and launched by the ESA in 2013, this helped deploy a satellite, but is now just space clutter.

De-orbit burn
Once ClearSpace-1 has secured Vespa, it will fire its rocket to break out of orbit, burning up in the atmosphere.

© ESA

The ESA's Lagrange mission will be a dedicated space weather observatory equidistant from Earth and the Sun

© ESA

© ESA

AR ZONE! SCAN HERE

SPACE DEBRIS

The satellites we depend on for communication, navigation and environmental monitoring are under increasing threat from all the junk that's up there in orbit with them. This includes derelict satellites and the rocket stages used to launch them, but if that was the extent of the problem there would be a manageably small number of objects to keep track of.

Unfortunately, those objects have a tendency to multiply, partly due to explosions caused by residual fuel and partly through collisions. Events like these can create thousands of smaller fragments, which due to their high speed and random orbits, pose at least as much risk as the original object.

Working satellites are equipped with manoeuvring thrusters so they can be moved to a different orbit if it's known that a piece of space debris is heading their way. With tens of thousands of objects large enough to cause serious problems, though, it's no easy task to keep track of all of them. Yet that's exactly what the space surveillance and tracking segment of the ESA's Space Situational Awareness programme has to do. It employs a network of telescopes, radars and laser-ranging stations to detect and track objects, then processes the resulting data at ESA mission control in Darmstadt, Germany. The latter will issue an alert if evasive action is deemed necessary.

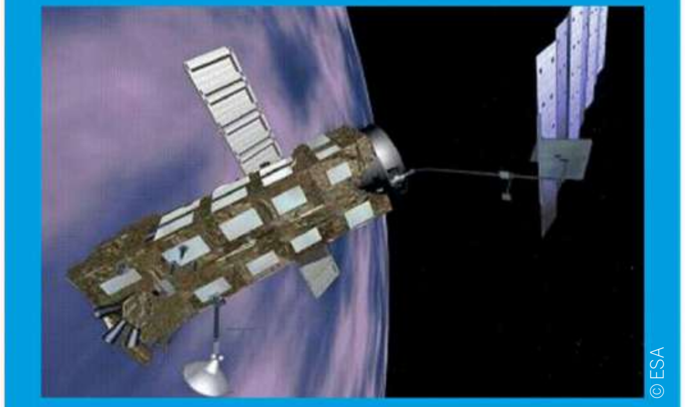
This system works well at the moment, but that won't always be the case. If things carry on as they are, the space debris problem will get much worse in the future. The number of new satellites being launched is higher than it has ever been, while the number of fragmentary objects is increasing due to ongoing collisions. The worry is that the amount of space debris could reach a tipping point, beyond which there is a continuous cascade of self-generating collisions. Known as Kessler syndrome, this would render certain orbits unusable if it continued unchecked. For this reason the ESA is also considering methods for the active removal of space debris. Its ClearSpace-1 mission, if it goes according to plan, will be the first in the world to remove a piece of space debris from orbit.

© ESA

Space debris can travel at speeds of up to 17,500 miles per hour when orbiting the Earth

The space junk top 50

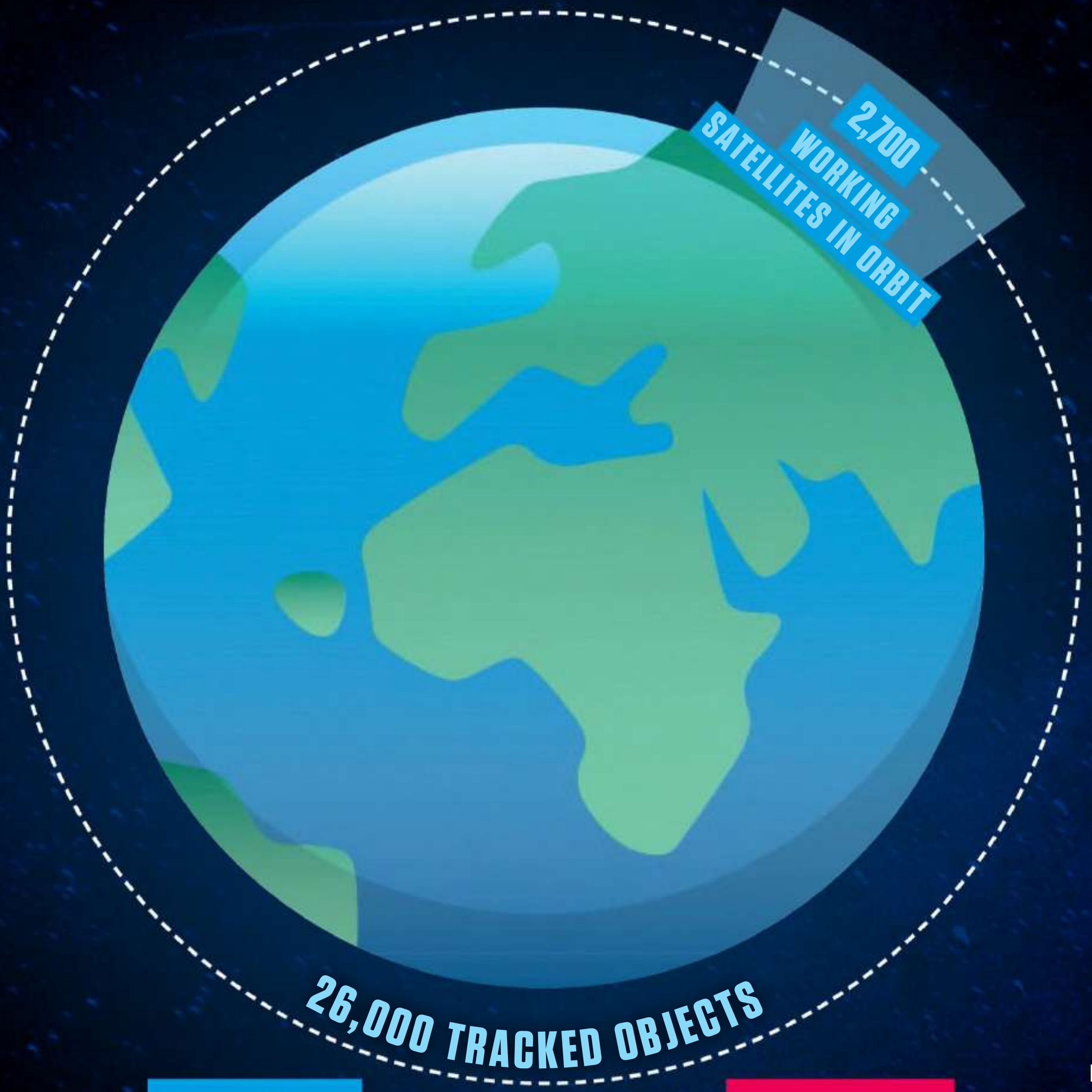
Although there are thousands of pieces of space junk, the most serious threats, not surprisingly, come from the largest objects. In October 2020, the International Astronautical Congress (IAC) was presented with a list of the 50 statistically most concerning debris objects. These were ranked not just by size, but also the persistence of their orbits and the likelihood of colliding with another object. More than three-quarters of the top 50 are spent launch stages that remain in orbit, while 80 per cent originated in the 20th century, before space agencies started taking specific measures to limit orbital debris. The ESA has the dubious honour of having the top-ranked satellite on the list – the now-defunct environmental monitoring satellite Envisat, launched in 2002.



© ESA

The ESA's Envisat, which has been derelict since 2012, is a potential space hazard

OUR COSMIC JUNKYARD



1,950

DISCARDED ROCKET STAGES

Although the lower stages of launch rockets fall back to Earth, the upper stages often end up in orbit.

2,850

DEFUNCT SATELLITES

Although satellites usually de-orbit at the end of their life, they may fail prematurely and end up stuck in orbit.

21,000

UNIDENTIFIED DEBRIS OBJECTS

This category covers objects large enough to be observed and tracked, but too small to identify specifically.

34,000

FRAGMENTS OVER TEN CENTIMETRES

These are below the threshold for surveillance and tracking, but numbers can be estimated.

900,000

FRAGMENTS UP TO TEN CENTIMETRES

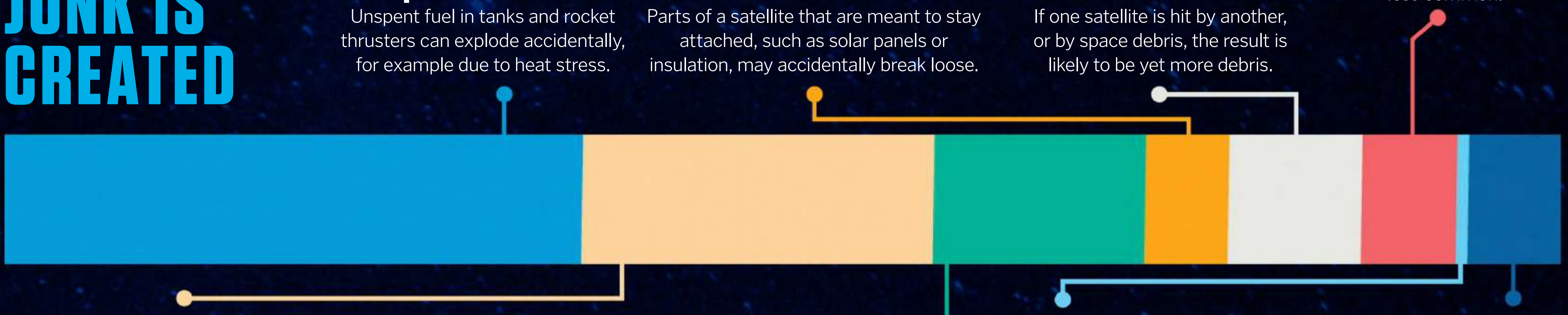
Even at this small size, objects can inflict considerable damage in a collision if the relative speed is high.

128 million

FRAGMENTS UP TO ONE CENTIMETRE

At the smallest size, serious damage is unlikely, but there can be cumulative sandblasting-like degradation, especially to solar panels.

HOW THIS JUNK IS CREATED



Propulsion: 39.52%
Unspent fuel in tanks and rocket thrusters can explode accidentally, for example due to heat stress.

Anomalous: 5.64%
Parts of a satellite that are meant to stay attached, such as solar panels or insulation, may accidentally break loose.

Collision: 9.01%
If one satellite is hit by another, or by space debris, the result is likely to be yet more debris.

Electrical: 6.4%
As with fuel explosions, satellites can also be destroyed by exploding batteries, although this is less common.

Deliberate: 23.77%
In the past, before fragmentation hazards were understood, satellites were sometimes blown up at the end of a mission.

Unknown: 14.29%
Objects here probably belong to one of the other categories, but there is insufficient evidence to say which.

Accidental: 0.8%
In a small number of cases, satellites may break up simply because they were badly designed.

Aerodynamics: 0.56%
Because satellites in low-altitude orbits are not in total vacuum, some have been broken up by atmospheric drag.

© ESA / Getty

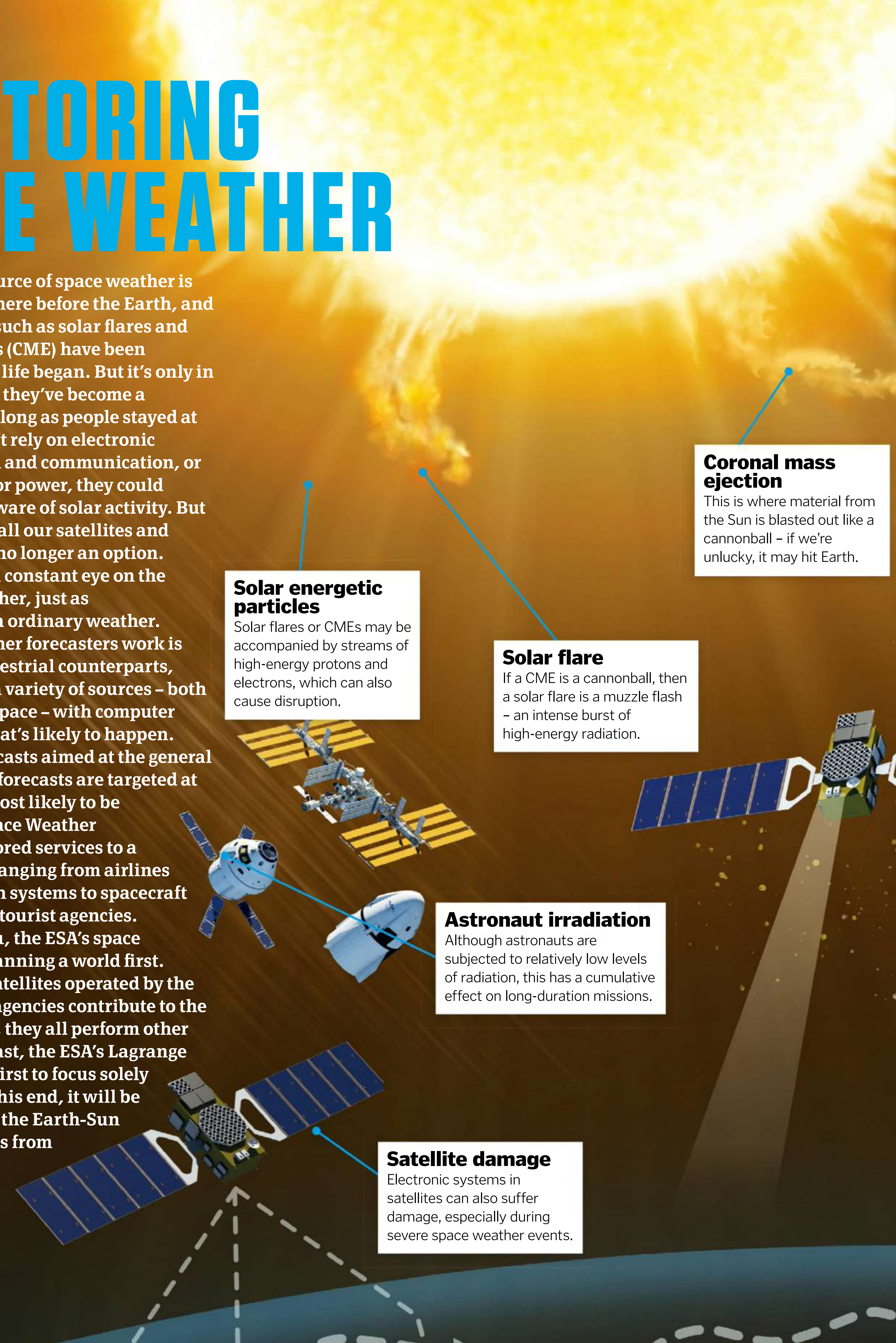
AR ZONE!

MONITORING SPACE WEATHER

On Earth, the main source of space weather is the Sun. The Sun was here before the Earth, and space weather events such as solar flares and coronal mass ejections (CME) have been occurring since before life began. But it's only in the modern world that they've become a significant hazard. As long as people stayed at ground level and didn't rely on electronic systems for navigation and communication, or on the electrical grid for power, they could remain blissfully unaware of solar activity. But in today's world, with all our satellites and electronic aids, that's no longer an option. Someone has to keep a constant eye on the vagaries of space weather, just as meteorologists do with ordinary weather.

The way space weather forecasters work is analogous to their terrestrial counterparts, combining data from a variety of sources – both on the ground and in space – with computer models to work out what's likely to happen. Unlike terrestrial forecasts aimed at the general public, space weather forecasts are targeted at the business sectors most likely to be affected. The ESA's Space Weather Network provides tailored services to a variety of industries, ranging from airlines and power distribution systems to spacecraft operators and auroral tourist agencies.

As with ClearSpace-1, the ESA's space weather segment is planning a world first. Although numerous satellites operated by the ESA, NASA and other agencies contribute to the space weather picture, they all perform other tasks as well. In contrast, the ESA's Lagrange spacecraft will be the first to focus solely on space weather. To this end, it will be positioned 'side-on' to the Earth-Sun axis, at equal distances from both, to give it the best possible view of solar storms heading towards our planet.



How space weather affects us

Solar storms, either in the form of radiation or ejected matter, have many adverse effects

Coronal mass ejection
This is where material from the Sun is blasted out like a cannonball – if we're unlucky, it may hit Earth.

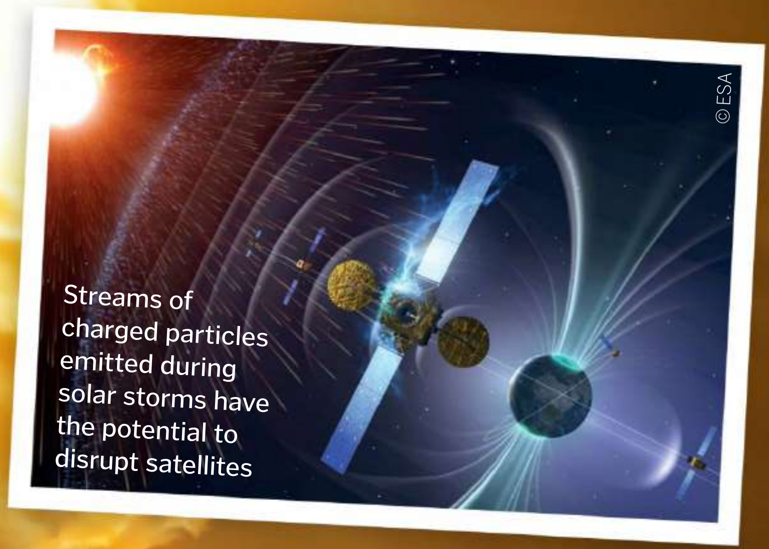
Solar energetic particles
Solar flares or CMEs may be accompanied by streams of high-energy protons and electrons, which can also cause disruption.

Solar flare
If a CME is a cannonball, then a solar flare is a muzzle flash – an intense burst of high-energy radiation.

Solar panel degradation
Space weather takes a steady toll on a satellite's solar panels, which generate less and less power over time.

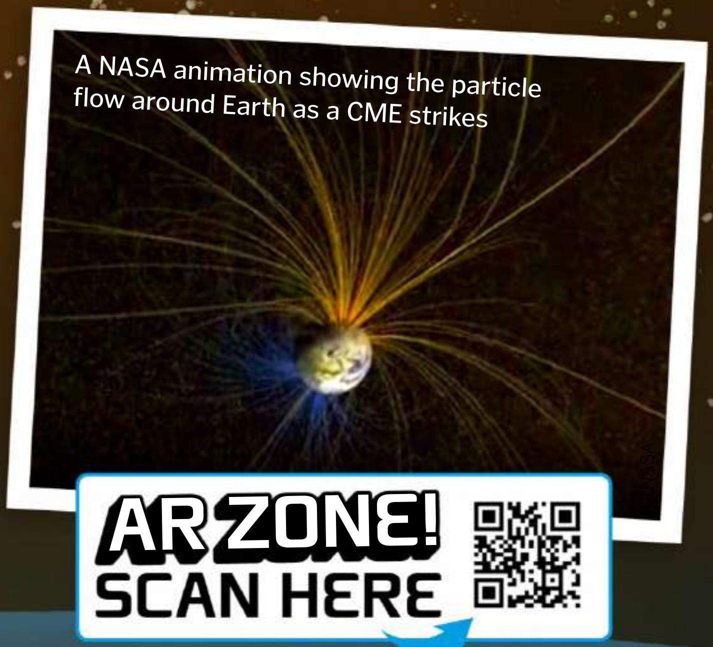
Astronaut irradiation
Although astronauts are subjected to relatively low levels of radiation, this has a cumulative effect on long-duration missions.

Satellite damage
Electronic systems in satellites can also suffer damage, especially during severe space weather events.



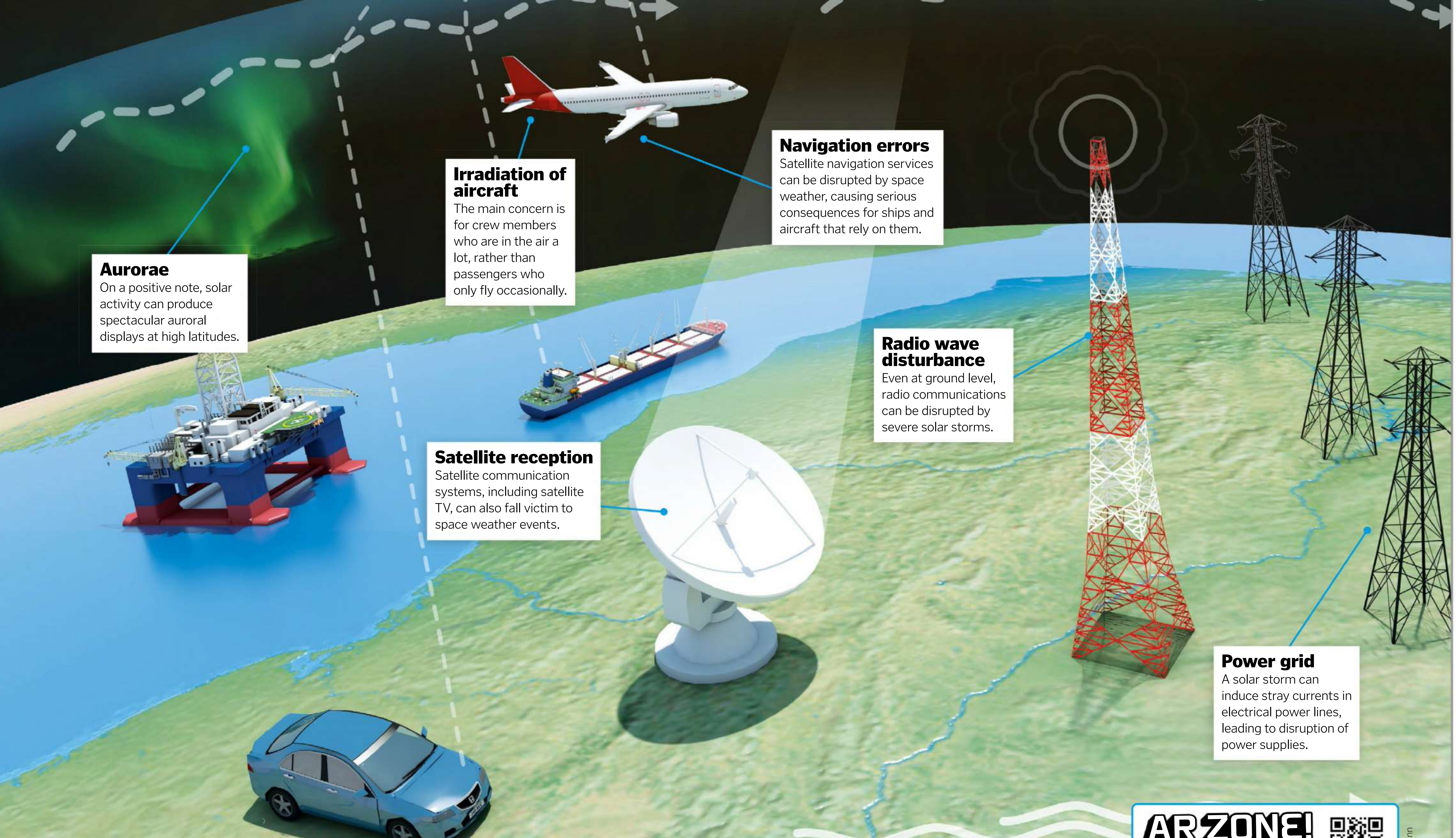
Streams of charged particles emitted during solar storms have the potential to disrupt satellites

© ESA



A NASA animation showing the particle flow around Earth as a CME strikes

AR ZONE! SCAN HERE



Aurorae
On a positive note, solar activity can produce spectacular auroral displays at high latitudes.

Irradiation of aircraft
The main concern is for crew members who are in the air a lot, rather than passengers who only fly occasionally.

Navigation errors
Satellite navigation services can be disrupted by space weather, causing serious consequences for ships and aircraft that rely on them.

Satellite reception
Satellite communication systems, including satellite TV, can also fall victim to space weather events.

Radio wave disturbance
Even at ground level, radio communications can be disrupted by severe solar storms.

Power grid
A solar storm can induce stray currents in electrical power lines, leading to disruption of power supplies.

AR ZONE! SCAN HERE

© Adrian Mann

NEAR-EARTH OBJECTS

Their name is slightly misleading, because near-Earth objects (NEOs) aren't always near Earth – they may be hundreds of millions of miles away on the other side of the Sun. But they're moving on orbits that cross Earth's orbit, or come close to it, which raises the risk of a future collision.

This doesn't necessarily spell disaster, because many NEOs are so small they will burn up as they enter the Earth's atmosphere. When it comes to asteroids or comets large enough to inflict serious damage, however, these can usually be detected by telescopes when they're still a long way from an impact. This is where the NEO segment of the ESA's Space Situational Awareness programme comes in.

The NEO segment is made up of a number of components, including a Europe-wide network of observers – both professionals and volunteers – to determine the current positions of NEOs. These observations then feed into a central analysis team, which uses the data to predict future orbits, assesses the collision risk and – if necessary – issues warnings to civil authorities if the predicted impact point lies inside Europe. The ESA is also investigating ways to deflect an incoming NEO before it hits Earth.

Artist's impression of a pair of asteroids passing close to Earth

© ESA

Cosmic clouds

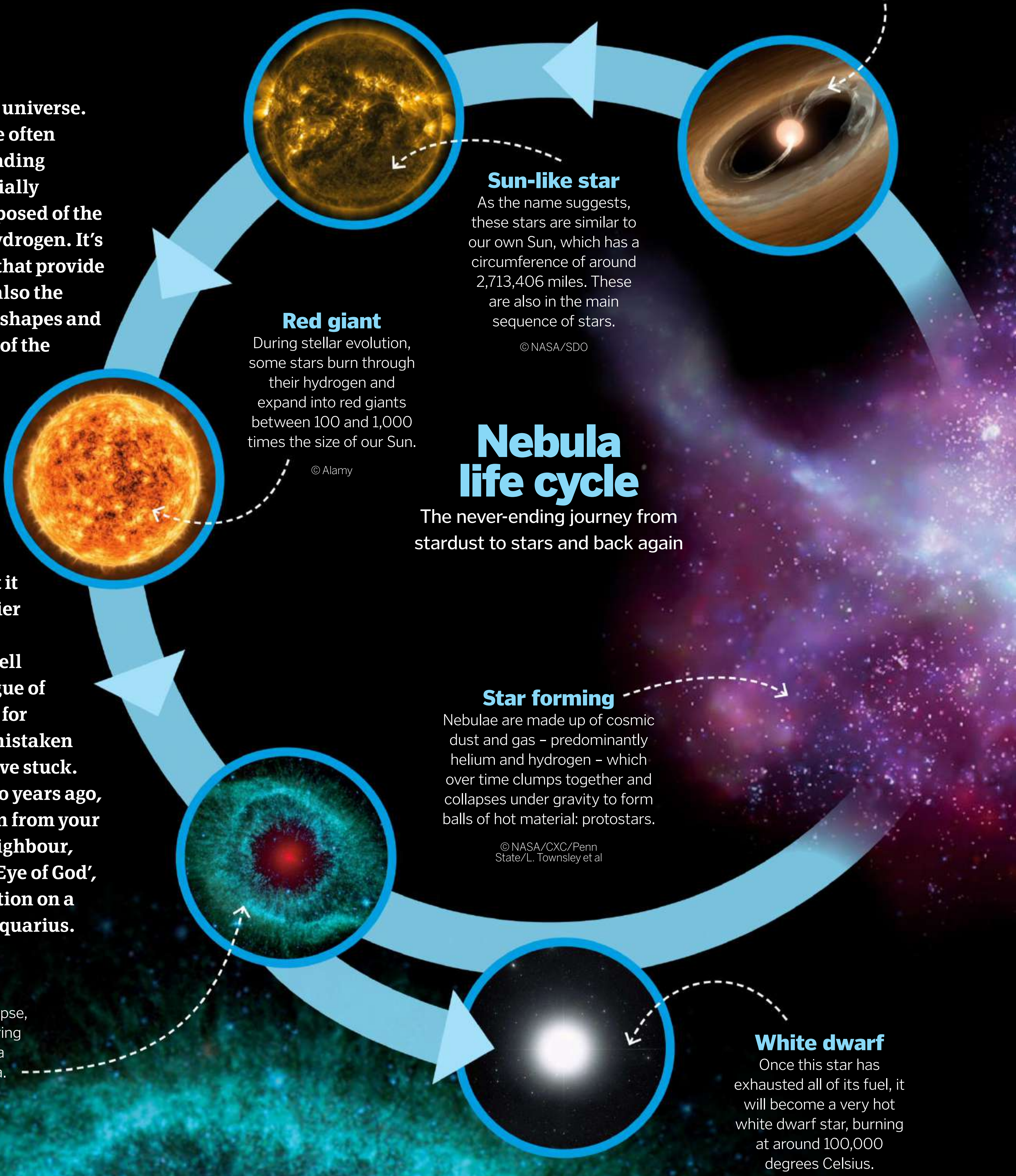
The birth, stellar offspring and demise of nebulae

Words by **Scott Dutfield**

Nebulae are the nurseries of the universe. They give birth to stars, but are often created when a star dies. Cascading throughout space, nebulae are essentially enormous clouds of dust and gas composed of the basic elements of the universe, like hydrogen. It's interactions between these elements that provide the building blocks for stars, and it's also the reason for the varied and spectacular shapes and sizes of nebulae. The explosive shape of the Crab Nebula, around 6,500 light years away, was created as the result of a star's supernova event, evicting masses of material in a cosmic eruption. Eventually the material that makes up the Crab Nebula will seed new stars.

The existence of nebulae has been recorded for well over 1,000 years, but it was French astronomer Charles Messier who was the first person to discover a planetary nebula in 1764 – the Dumbbell Nebula – going on to compile a catalogue of nebulae. Strangely enough, the name for planetary nebulae comes from their mistaken identity as planets – but it seems to have stuck.

Much like Messier observed over 250 years ago, some of these space clouds can be seen from your back garden. Our closest nebulous neighbour, the Helix Nebula, also known as the 'Eye of God', can be seen in areas of low light pollution on a clear night near the constellation of Aquarius.



Nebula life cycle

The never-ending journey from stardust to stars and back again

Protostar

As newborns, protostars continue to feed on stardust and gas to increase their mass until they are large enough to enter the main sequence of stars. This stage lasts between 100,000 and 10 million years.

© Caltech/T. Pyle (IPAC)

Sun-like star

As the name suggests, these stars are similar to our own Sun, which has a circumference of around 2,713,406 miles. These are also in the main sequence of stars.

© NASA/SDO

Red giant

During stellar evolution, some stars burn through their hydrogen and expand into red giants between 100 and 1,000 times the size of our Sun.

© Alamy

Star forming

Nebulae are made up of cosmic dust and gas – predominantly helium and hydrogen – which over time clumps together and collapses under gravity to form balls of hot material: protostars.

© NASA/CXC/Penn State/L. Townsley et al

Planetary nebula

At the end of a red giant's life, it will collapse, having used up all its hydrogen fuel. During this process, the former giant ejects a gas-and-dust shell: a planetary nebula.

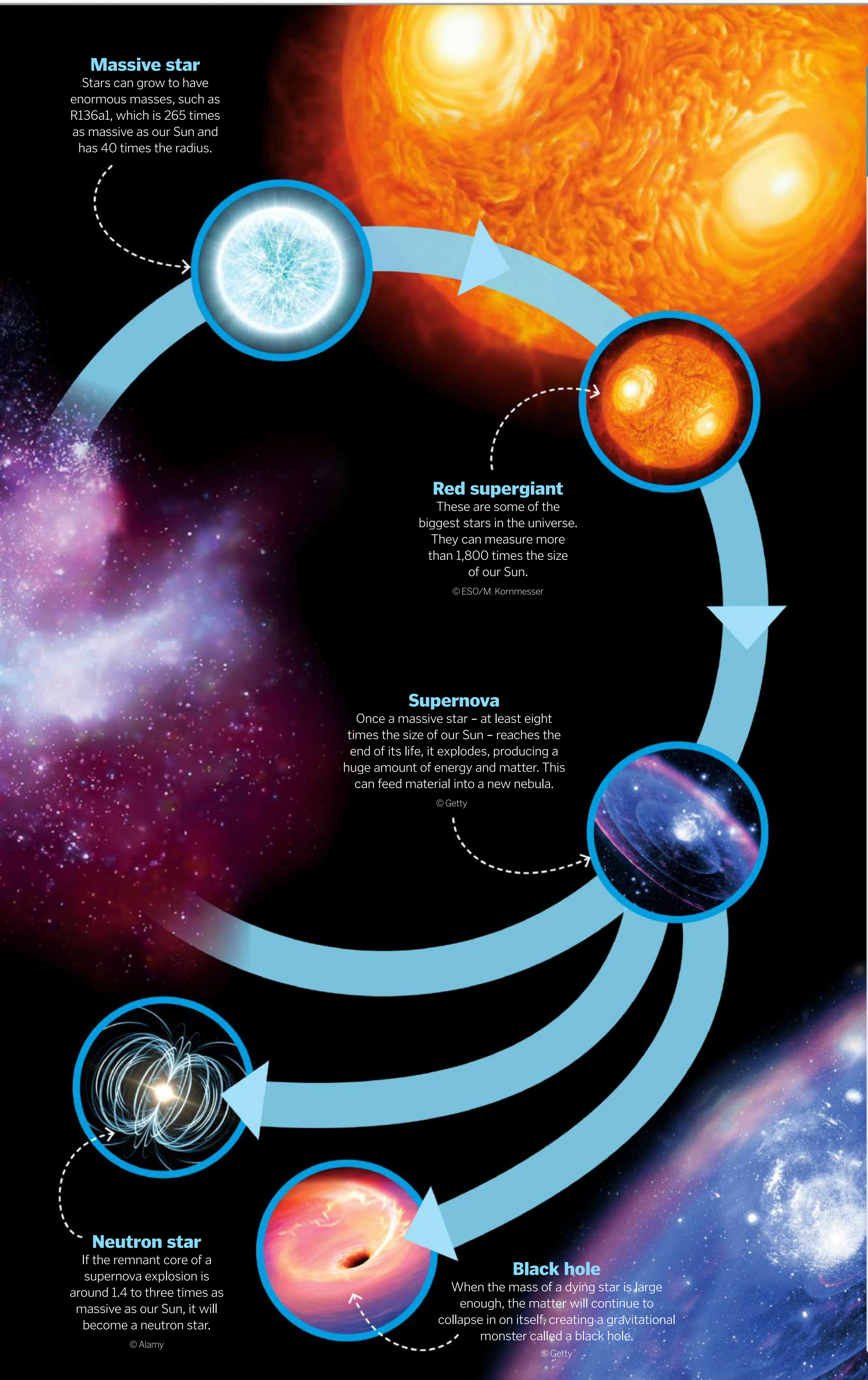
© NASA, JPL-Caltech, Kate Su (Steward Obs. U. Arizona) et al

White dwarf

Once this star has exhausted all of its fuel, it will become a very hot white dwarf star, burning at around 100,000 degrees Celsius.

© ESA/Hubble and Digitized Sky Survey 2

DID YOU KNOW? *The largest known nebula, the Tarantula Nebula, stretches across more than 1,800 light years*



Massive star

Stars can grow to have enormous masses, such as R136a1, which is 265 times as massive as our Sun and has 40 times the radius.

Red supergiant

These are some of the biggest stars in the universe. They can measure more than 1,800 times the size of our Sun.

© ESO/M. Kornmesser

Supernova

Once a massive star – at least eight times the size of our Sun – reaches the end of its life, it explodes, producing a huge amount of energy and matter. This can feed material into a new nebula.

© Getty

Neutron star

If the remnant core of a supernova explosion is around 1.4 to three times as massive as our Sun, it will become a neutron star.

© Alamy

Black hole

When the mass of a dying star is large enough, the matter will continue to collapse in on itself, creating a gravitational monster called a black hole.

© Getty

TYPES OF NEBULA

EMISSION NEBULAE

© ESO

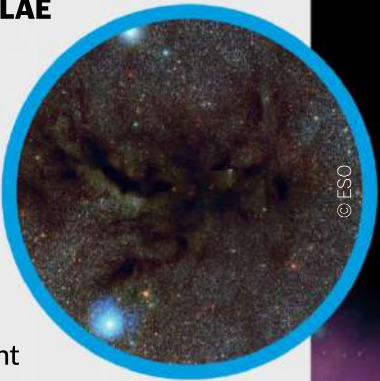
These are emissions of ionised gas energised by cosmic ultraviolet light, glowing almost like a neon light. The Cat's Paw Nebula, around 5,500 light years away, gets its red colour from ionised hydrogen atoms.

REFLECTION NEBULAE

© NASA/STScI Digitized Sky Survey/Noel Carboni

Unlike emission nebulae, this type of nebula does not emit UV light. Instead they rely on the light emitted from a neighbouring star to illuminate them, as seen with the Witch Head Nebula.

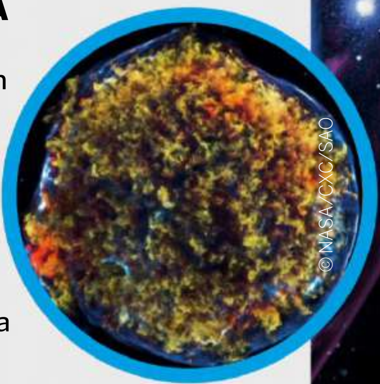
DARK NEBULAE



© ESO

Much like a reflection nebula, these dust clouds don't emit their own light. But instead of reflecting light from other sources, they block it out. This is partly because they contain interstellar grains of dust a few microns across, along with graphite and ice.

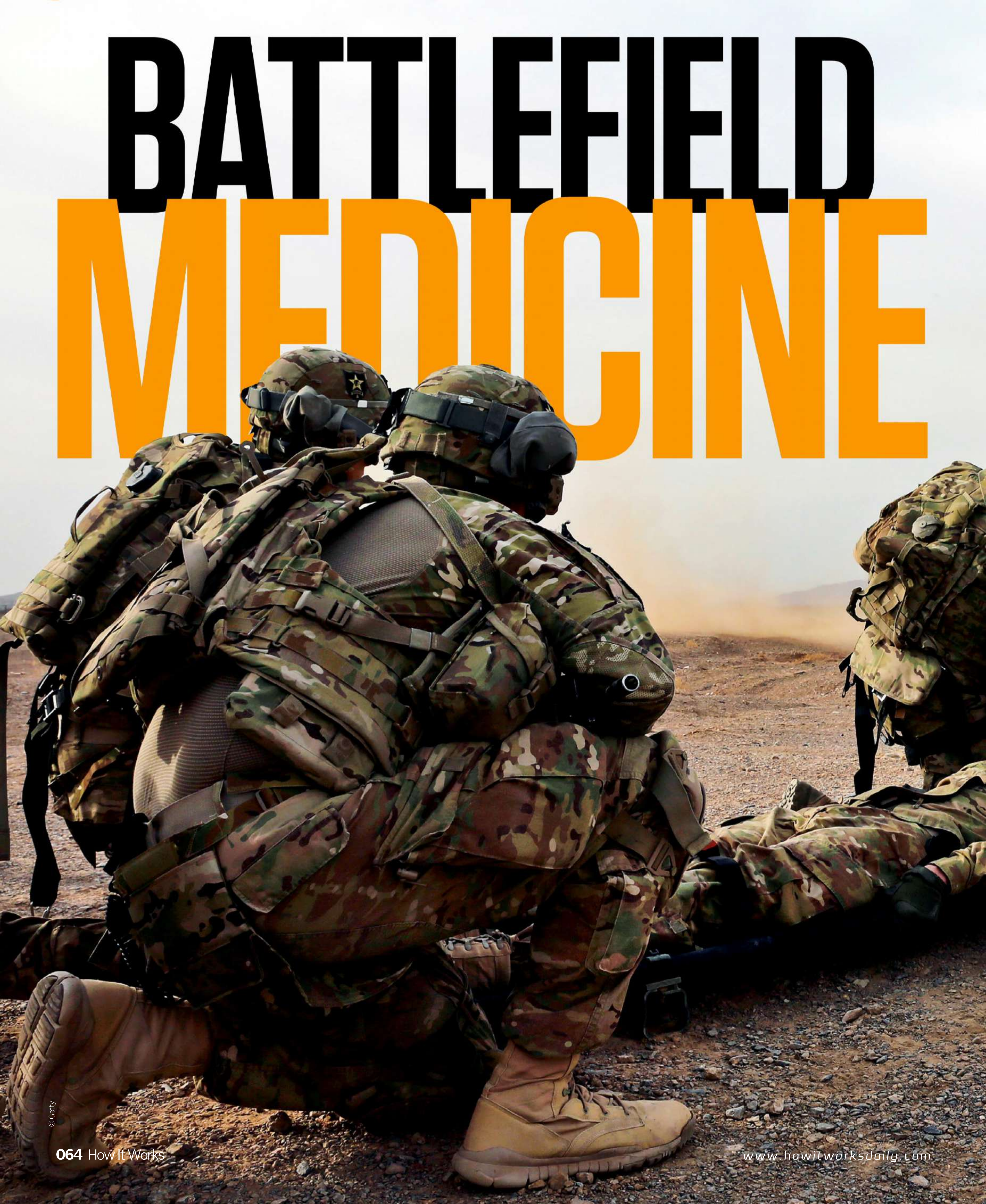
SUPERNOVA REMNANT



© NASA/CXC/SAO

When certain giant stars die, they radiate their matter as an explosion that creates a supernova remnant. These firework-like nebulae are bound by powerful shock waves that ripple through space, heating up and stirring interstellar matter as they go.

BATTLEFIELD MEDICINE



© Getty

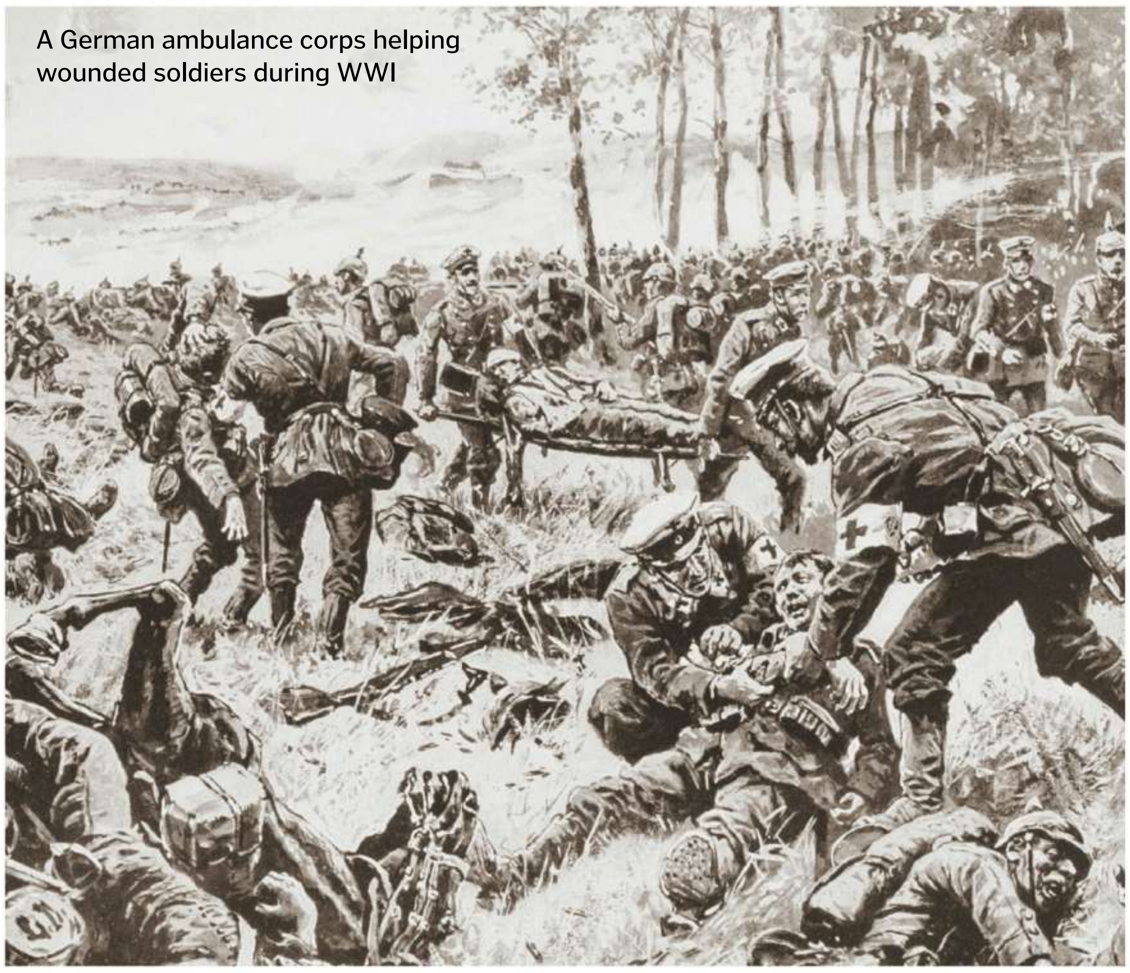
HOW MILITARY MEDICS SAVE THE LIVES OF SOLDIERS DURING CONFLICT

Words by **Scott Dutfield**

All throughout history, conflicts around the world have directly affected how civilian medicine has evolved, with countless advancements and inventions born on the battlefield. During his reign from 27 BCE to 14 CE, the Roman emperor Augustus was one of the first to establish military medical academies to train an army of war doctors to treat his fallen soldiers. These Roman surgeons were given practical experience on the battlefield and carried tool kits containing earlier versions of inventions that are still used today, such as scalpels, forceps and tourniquets.

Dominique Jean Larrey, a French surgeon, is credited with inventing a lightweight horse-drawn wagon to ferry fallen soldiers quickly from the battlefield to receive immediate care in the late 1700s. These wagons were known as 'flying ambulances' and were the start of the development of the modern-day ambulance. Larrey is often referred to as the first military surgeon, pioneering amputation techniques and gunshot wound treatments. He was also the first to treat fallen soldiers according to the severity of their injuries, now referred to as triage, as opposed to their social class.

One of the biggest advancements in medicine came about during World War II: the development of the drug penicillin. Though the 'miracle drug' was accidentally discovered by Alexander Fleming in 1928, penicillin has saved countless military and civilian lives since. As the world's first antibiotic, Fleming noticed that bacteria couldn't survive in its presence, but ceased work on the drug in 1931, having published his findings in 1929. However, scientists Howard W. Florey and Ernst B. Chain



A German ambulance corps helping wounded soldiers during WWI

© Getty

continued the drug's development on the cusp of World War II. Florey took penicillin research to the US, which had just joined Britain's side in the war, in December 1941. Seeing the potential to save many soldiers' lives from infections that had devastated the ranks in World War I, the US agreed to produce the drug. By 1944, US companies were producing 100 billion units of penicillin per month.

MODERN-DAY MEDICINE

Every country has its own structure and strategies to provide a medical response. All soldiers, sailors and airmen are instructed and trained to deliver the same life-saving care. In the British Armed Forces, at the point a soldier has incurred a combat injury, such as a bullet wound, burn or broken bone, what follows is known as pre-hospital emergency care. Ideally, no more than the next two hours are spent stabilising the injured soldier in preparation for delivery to a hospital for further treatment.

"Within ten minutes of injury – we call this the platinum ten minutes – soldiers should have immediate life-saving care delivered to them," says Lieutenant Colonel Harvey Pynn, defence consultant advisor in pre-hospital emergency care. This care is delivered by their nearest colleague – all personnel receive annual training in life-saving first aid. "In this sort of instance, they stop life-threatening bleeding, keep airways open and make sure patients are safe and they survive that initial insult," adds Pynn.

Every UK serviceman or woman carries a certain amount of medical equipment, which includes medical gloves, two tourniquets and an emergency pressure dressing. Tourniquets help to combat catastrophic external haemorrhage on a limb. When vital arteries or veins are severed, 40 per cent of blood can be lost within three to four minutes. These vice-like devices work to squeeze blood vessels against solid structures such as bone, stopping blood flow through the vessels and preventing large amounts of blood loss. "Tourniquets probably saved more lives during the Afghanistan campaign than any other intervention," says Pynn.

To provide immediate pain relief, all UK service personnel carry a small lollipop-looking device called a fentanyl lozenge. However, rather than sucking on the lozenge, it's rubbed on the cheeks of the patient to release the strong opiate drug, which much like morphine is an effective painkiller.

Medical care is continuous. Once life-threatening external bleeding has been addressed in the platinum ten minutes, further life-saving interventions are undertaken as soon as possible thereafter. Combat medics – who receive 26 weeks of medical training – are rapidly deployed or the casualty is brought to them. A combat medic will have a greater range of medical skills and will commence 'damage control resuscitation', focusing on replacing lost blood. To address some of the most critical patient injuries, combat medics descend upon the patient with several pieces of life-saving equipment and medication.

One of these life-saving medications is tranexamic acid (TXA), administered via blood

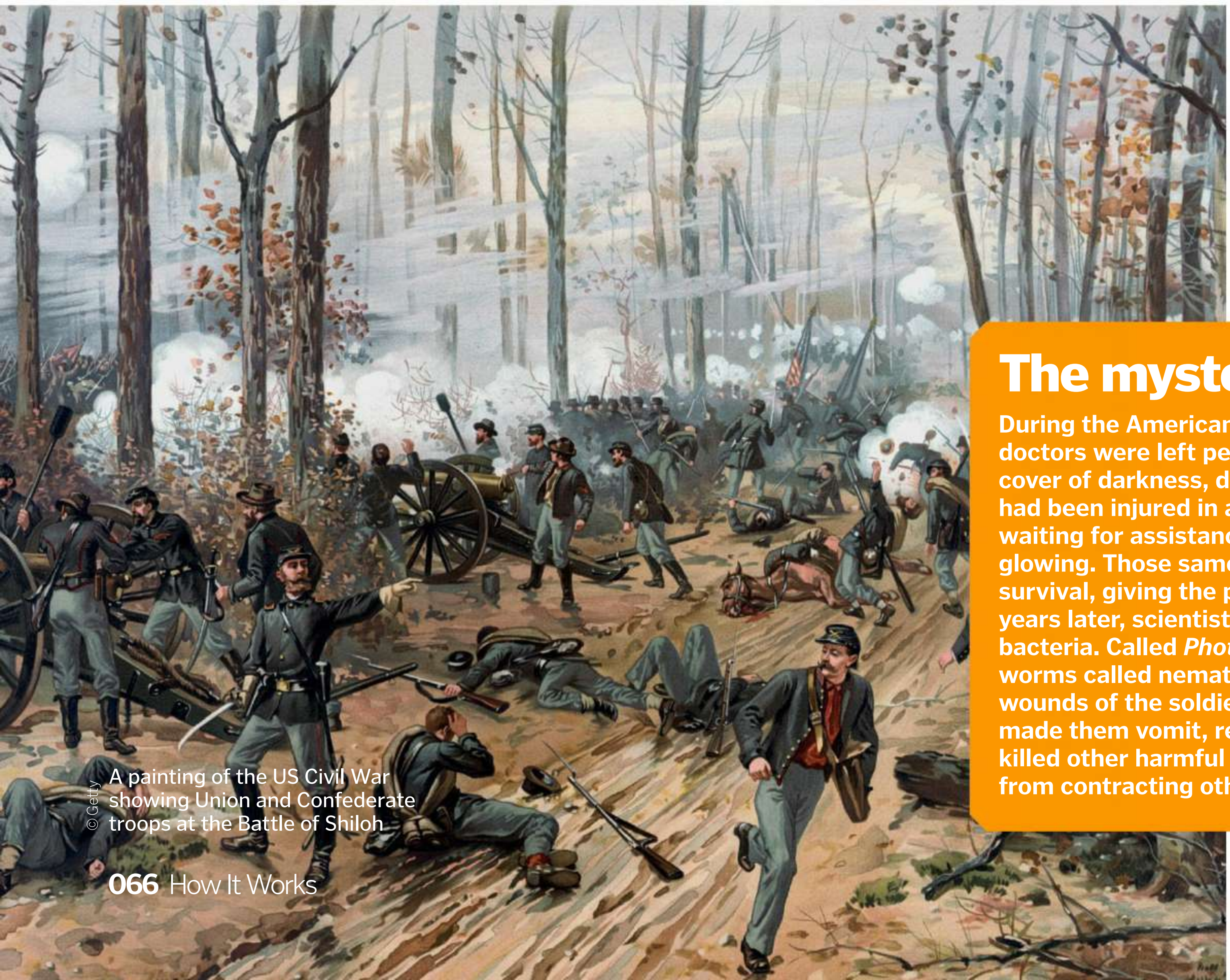
Off the battlefield

Medical care for military personnel doesn't end on the battlefield, and methods of rehabilitation continually evolve too, particularly in prosthetics. One traumatic injury that often occurs during conflicts is the loss of limbs. Between 2001 and 2019, there were 301 UK military personnel who experienced traumatic or surgical amputation due to injuries sustained in Afghanistan.

Advancements in prosthetics have helped to rehabilitate those people. In 1997, prostheses creators Ottobock introduced the first fully microprocessor-controlled knee, called the C-Leg. This revolutionary prosthetic has enabled civilians and soldiers alike to walk again. This machinery uses an internal computer to control the movement of the leg hydraulically, an improvement on older mechanical prosthetics.

© Getty

Prosthetics have allowed injured soldiers to regain mobility



© Getty

A painting of the US Civil War showing Union and Confederate troops at the Battle of Shiloh

The mystery of angel glow

During the American Civil War, at the Battle of Shiloh in 1862, army doctors were left perplexed by a strange phenomenon. Under cover of darkness, doctors searched for the bodies of soldiers who had been injured in an unexpected attack during the day. While waiting for assistance, some soldiers noticed their wounds were glowing. Those same soldiers reportedly had a higher chance of survival, giving the phenomenon the name 'angel glow'. Nearly 150 years later, scientists figured out the cause: bioluminescent bacteria. Called *Photorhabdus luminescens*, it lived inside parasitic worms called nematodes, which had made their way into the wounds of the soldiers. Once inside the nematodes, *P. luminescens* made them vomit, releasing the bacteria along with chemicals that killed other harmful bacteria and pathogens, preventing soldiers from contracting other deadly infections.

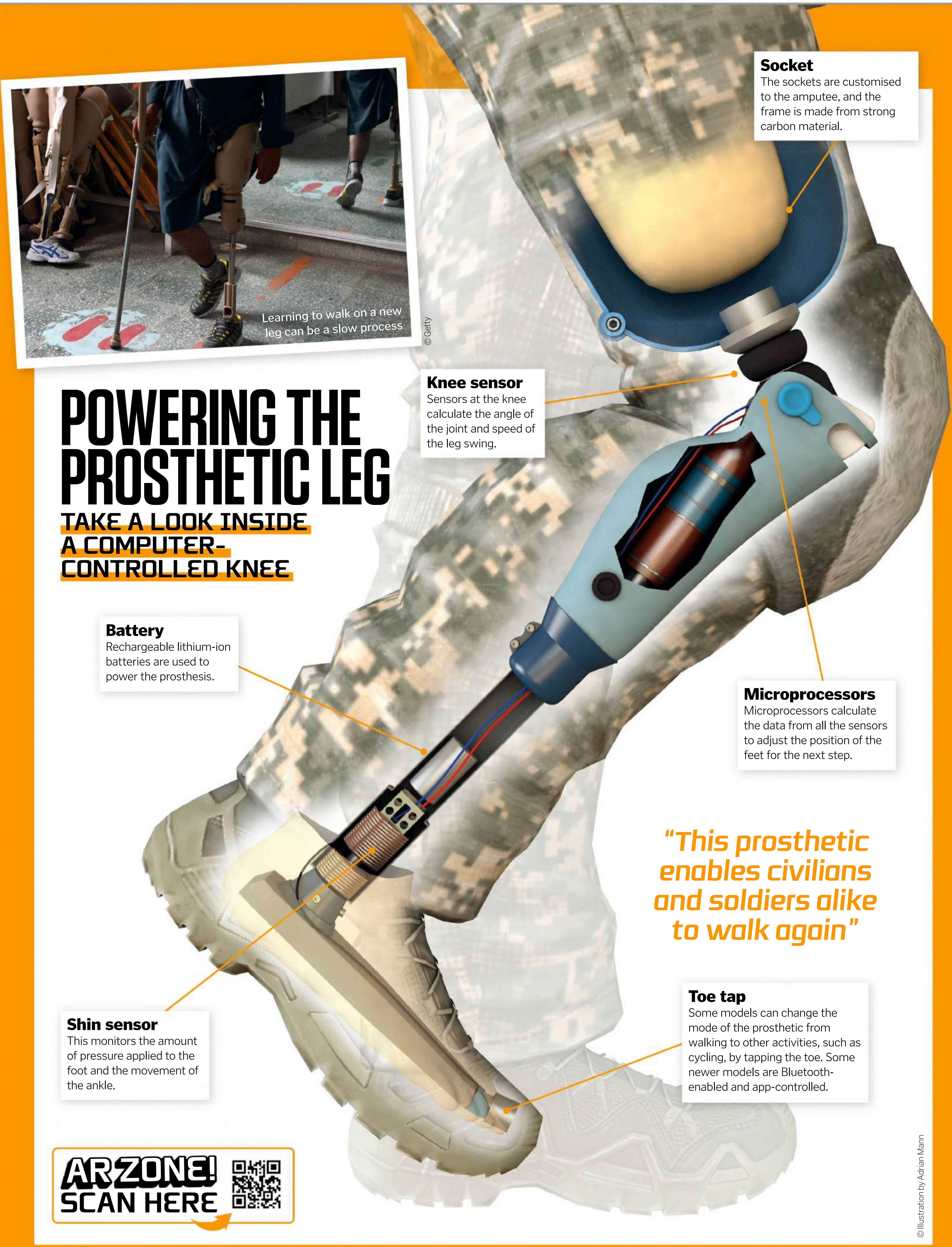
DID YOU KNOW? *At least 108 million people were killed in wars during the 20th century*

POWERING THE PROSTHETIC LEG

TAKE A LOOK INSIDE A COMPUTER-CONTROLLED KNEE

Learning to walk on a new leg can be a slow process

© Getty



Socket
The sockets are customised to the amputee, and the frame is made from strong carbon material.

Knee sensor
Sensors at the knee calculate the angle of the joint and speed of the leg swing.

Battery
Rechargeable lithium-ion batteries are used to power the prosthesis.

Microprocessors
Microprocessors calculate the data from all the sensors to adjust the position of the feet for the next step.

> *"This prosthetic enables civilians and soldiers alike to walk again"*

Shin sensor
This monitors the amount of pressure applied to the foot and the movement of the ankle.

Toe tap
Some models can change the mode of the prosthetic from walking to other activities, such as cycling, by tapping the toe. Some newer models are Bluetooth-enabled and app-controlled.

AR ZONE! SCAN HERE

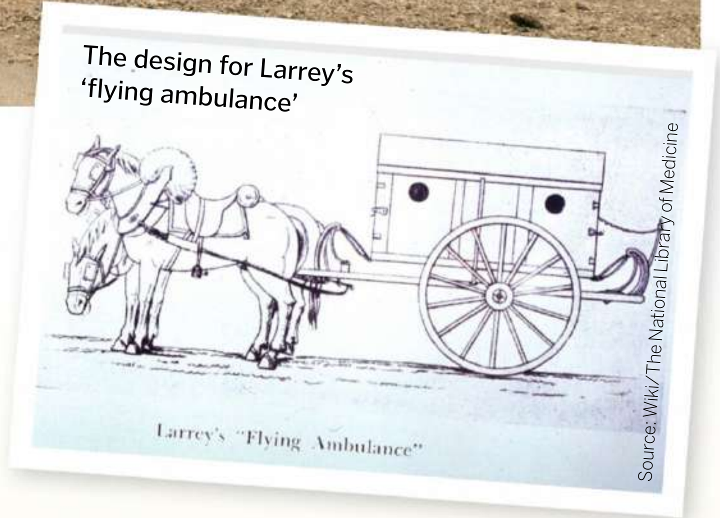
© Illustration by Adrian Mann

vessels or into bone marrow. When the body experiences heavy bleeding, its natural function is to cycle the formation of blood clots and then break them down again. When suffering traumatic injuries it's important to preserve and stabilise any clot that has formed – this is the role of TXA. Along with TXA, battlefield medics are equipped with an array of trauma-tackling equipment, including adjuncts to keep airways open, chest seals for open chest wounds, splints for broken bones and pelvic binders to stem any internal bleeding within the pelvis.

By the hour mark, it's hoped that highly trained paramedics, nurses and doctors will have intervened and begun work to resuscitate the patient. This typically centres around restoring respiratory function and replacing lost blood. The UK military has a medical system whereby the capability of the emergency room is taken to the patient to save precious time for the critically injured patient. This is a two to four person medical emergency response team (MERT). The aim of the MERT is to augment the life-saving treatment already given and provide critical care interventions, such as anaesthesia, to resuscitate and stabilise the patient during the transfer to the hospital. Blood products are carried cold by the MERT. They are transfused via a warming device so that the patient receives blood at body temperature. "We hope to be at the hospital doors within two hours of injury to enable further resuscitation," says Pynn.

The IAI Heron unmanned aerial vehicle, the newest in the Israeli Air Force

© Getty



The design for Larrey's 'flying ambulance'

Source: Wiki/The National Library of Medicine

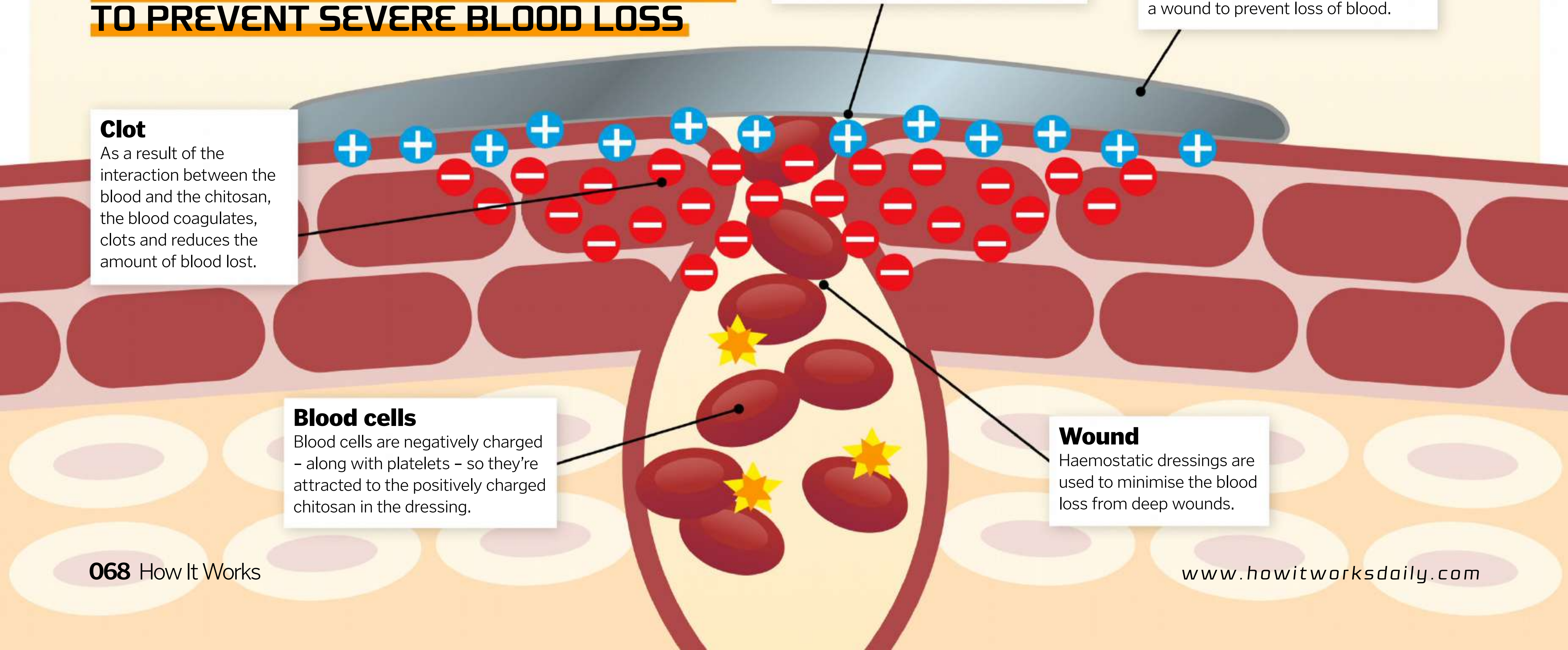
THE FUTURE OF MILITARY MEDICINE

Advances in military prehospital emergency care continue to evolve. Service personnel using wearable technology to monitor a soldier's respiratory system and heart rate in combat will give medics vital information to plan treatment.

Drones are being trialled to transport blood products to areas of conflict too remote or dangerous for medics, as well as to transfer casualties short distances to safer areas where the MERT can continue life-saving interventions. Following advanced medical intervention, more advanced drones will be designed to ferry injured soldiers remotely out of the battlefield, transferring them without medical escort while controlling pumps, monitors and infusions in response to the patient's currently physiology and delivering them to a hospital – the Israelis are trialling the Heron unmanned aerial vehicle for this purpose. It's vital for military prehospital emergency care to evolve when not engaged in conflict so it's ready when the time comes.

HAEMOSTATIC HEALING

HOW THIS WOUND DRESSING HELPS TO PREVENT SEVERE BLOOD LOSS



Chitosan
The dressing contains a natural polymer called chitosan, which is obtained from crustaceans like crabs or shrimp. The chitosan is positively charged.

Dressing
These come in all shapes and sizes for surface wounds, and even come in pellet form to be injected deep within a wound to prevent loss of blood.

Clot
As a result of the interaction between the blood and the chitosan, the blood coagulates, clots and reduces the amount of blood lost.

Blood cells
Blood cells are negatively charged – along with platelets – so they're attracted to the positively charged chitosan in the dressing.

Wound
Haemostatic dressings are used to minimise the blood loss from deep wounds.

DID YOU KNOW? *Around 500,000 amputations were performed during WWI*

Q&A LT. COL. HARVEY PYNN

WE SPEAK TO A ROYAL ARMY MEDICAL CORPS VETERAN ABOUT WHAT CIVILIAN MEDICINE HAS LEARNED FROM THE BATTLEFIELD

Pynn is defence consultant advisor in Pre-Hospital Emergency Care (PHEC) to the UK Surgeon General. He has undertaken multiple operational tours across the world while serving in the Armed Forces over the last 22 years.

What is one of the biggest challenges medics face in the field?

The biggest challenges anyone providing medical care has to face on a battlefield is the situation itself. Very austere situations, climatically challenging situations – we don't tend to go to war in nice places. That's the overwhelming challenge to anyone trying to deliver care, that your own personal safety is not guaranteed.

In terms of logistics, getting blood products forward is challenging. But one thing the UK military has done very well is manage the logistic chain for blood products. We get great support from the NHS blood transfusion service. It's got a shelf life of 28 days – you can maximally push it to 35 days, but for planning purposes it's 28. That's a huge logistic burden. We have a system that can deliver cold blood products as far forward as possible so that patients can be resuscitated at an early stage with blood products such as red cells. Plasma is more difficult and more logistically challenging, but what we tend to use far forward is freeze-dried plasma. In Germany and France they manufacture freeze-dried plasma – at points of injury you can reconstitute it with sterile water.

How do you maintain the temperature of blood stores?

Blood is kept cold in something called a golden hour box, which is a bit of a misnomer because it keeps blood cold for 48 to 72 hours. It's an insulated box with big ice packs, which need to be reconstituted in a freezer every two to three days. These golden hour boxes can be anything from the size of a shoebox, carrying around two units of blood, to something a lot bigger that can carry 12 to 20 units of blood and keep blood cool for three to five days.

How has pre-hospital emergency care changed over your career?

There's not much good that comes out of war, but one of the things that does come out of war is advances in medical capability and technology. Between periods of conflict, we tend to forget the lessons that we've learned in the last conflict, and we spend a little bit of time relearning those lessons. But we've had a sustained period of conflict across the globe over the last 20 to 30 years that the UK military has been involved in, to a greater or lesser degree. We have learned an awful lot of lessons from a medical standpoint that have crept, some slowly and some more quickly, into the NHS.

Things that have evolved are widespread use of tourniquets at points of injury and battlefield analgesia with fentanyl lozenges, which replaced the morphine auto-injectors. Also, something called haemostatic dressings. These are dressings that have a clotting agent within them, so that when the dressings are stuffed down into the wound, they promote clotting. The UK military uses something called Celox Rapid, which is basically a gauze that's impregnated with something called chitosan. You stuff this dressing down into a wound and apply pressure, and that aids clotting, so it's better than just stuffing a wound with gauze. Haemostatic dressings were developed by the US. Now they are routinely carried by military team medics and by the NHS.

© Great Western Air Ambulance Charity

Making light of helium

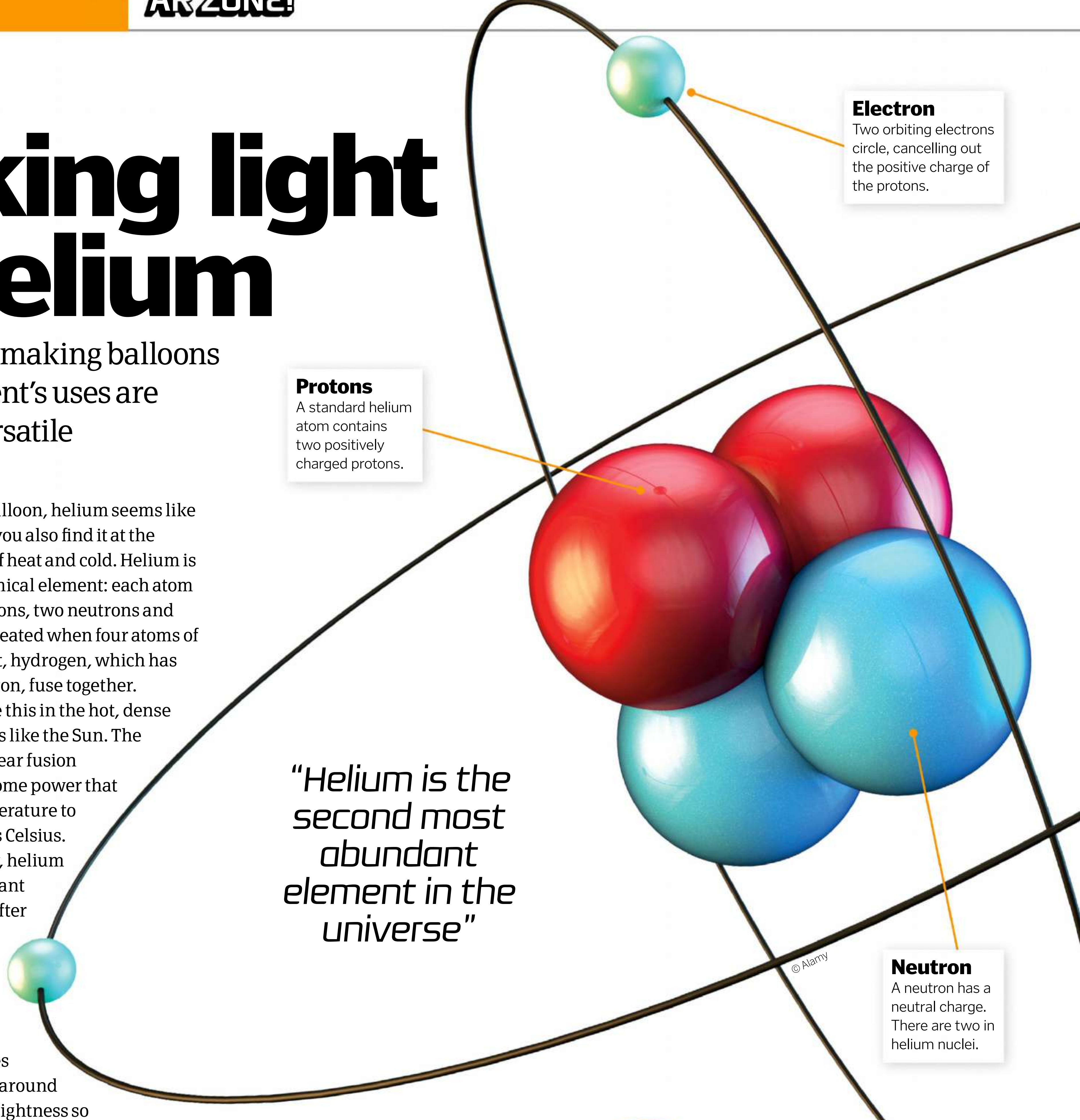
Known best for making balloons float, this element's uses are surprisingly versatile

Words by **Andy Extance**

Floating in a party balloon, helium seems like harmless fun – but you also find it at the furthest extremes of heat and cold. Helium is the second-simplest chemical element: each atom is built from just two protons, two neutrons and two electrons. It can be created when four atoms of the very simplest element, hydrogen, which has one proton and one electron, fuse together. Hydrogen transforms like this in the hot, dense conditions we find in stars like the Sun. The hydrogen-to-helium nuclear fusion process creates the awesome power that takes the Sun's core temperature to around 15 million degrees Celsius.

Being made in this way, helium is the second most abundant element in the universe after hydrogen. But here on Earth, it's surprisingly rare. The combination of two protons, two neutrons and two electrons give it properties that mean it doesn't stick around for long, including in the lightness so prized in balloons. Being so lightweight, it can easily escape the planet's gravitational pull and drift out into space. It's also chemically very stable, so doesn't react easily with other heavier substances that might keep it on Earth. That stability is what makes helium preferable for use in balloons to hydrogen, which is lighter still, but burns easily and dangerously.

What's even more useful about helium is that despite being born from the fiery heart of stars, it can be the coldest thing on Earth. Changing it from gas to liquid means cooling it below its boiling point of -268.9 degrees Celsius. This makes helium very valuable for accessing properties that only show up when materials are this cold. For example, it allows us to use superconductor materials that can be very strong magnets, found in MRI scanners. For such a lightweight element, helium has a heavyweight impact when used like this.



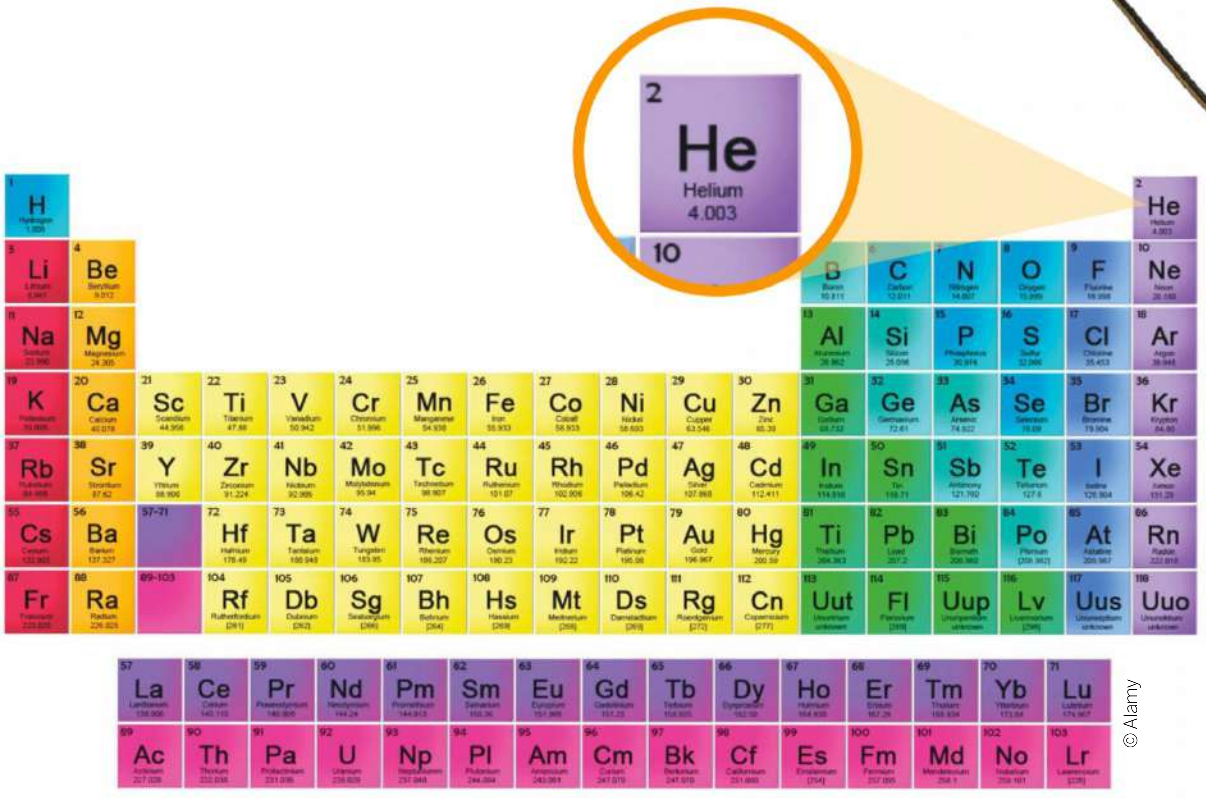
Electron
Two orbiting electrons circle, cancelling out the positive charge of the protons.

Protons
A standard helium atom contains two positively charged protons.

Neutron
A neutron has a neutral charge. There are two in helium nuclei.

© Alamy

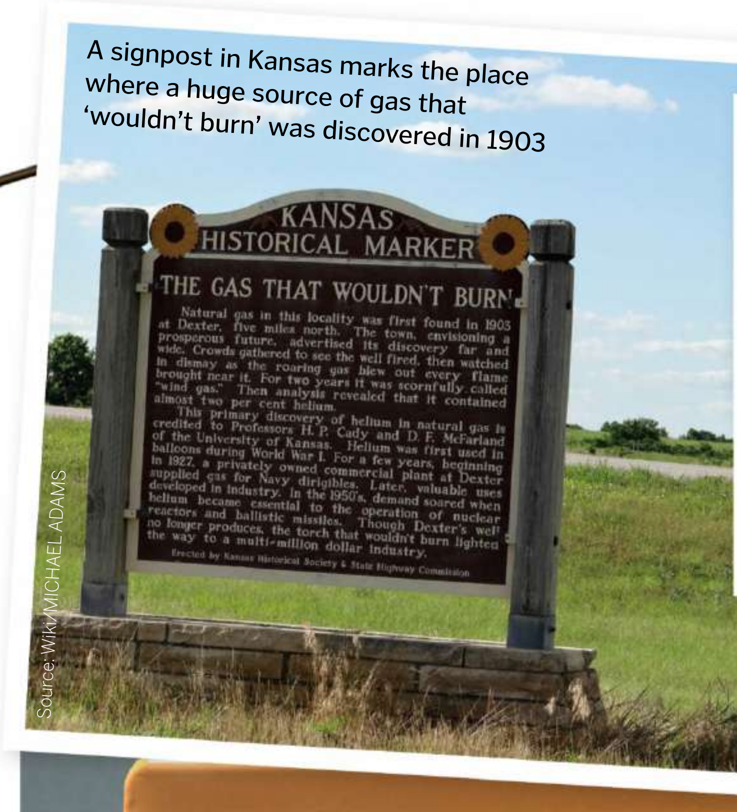
> *"Helium is the second most abundant element in the universe"*


2
He
Helium
4.003
10
H
Li Be B C N O F Ne
Na Mg Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
Cs Ba 57-71 Hf Ta W Re Os Ir Pt Au Hg Ti Pb Bi Po At Rn
Fr Ra 89-103 Rf Db Sg Bh Hs Mt Ds Rg Cn Uut Fl Uup Lv Uus Uuo
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Ac Th Pa U Np Pl Am Cm Bk Cf Es Fm Md No Lr

© Alamy

Helium is the first of the noble gases in the periodic table of elements

A signpost in Kansas marks the place where a huge source of gas that 'wouldn't burn' was discovered in 1903



KANSAS
HISTORICAL MARKER

THE GAS THAT WOULDN'T BURN

Natural gas in this locality was first found in 1903 at Dexter, five miles north. The town, envisioning a prosperous future, advertised its discovery far and wide. Crowds gathered to see the well fired, then watched in dismay as the roaring gas blew out every flame brought near it. For two years it was scornfully called "wind gas." Then analysis revealed that it contained almost two per cent helium.

This primary discovery of helium in natural gas is credited to Professors H. P. Cady and D. F. McFarland of the University of Kansas. Helium was first used in balloons during World War I. For a few years, beginning in 1927, a privately owned commercial plant at Dexter supplied gas for Navy dirigibles. Later, valuable uses developed in industry. In the 1950's, demand soared when helium became essential to the operation of nuclear reactors and ballistic missiles. Though Dexter's well no longer produces, the torch that wouldn't burn lighted the way to a multi-million dollar industry.

Erected by Kansas Historical Society & State Highway Commission

Source: Wiki/MICHAEL ADAMS

AR ZONE! SCAN HERE

© Getty

This ultra-cold biological transport unit uses helium to refrigerate and safely transport COVID-19 vaccines

CRYO-
POWER ON

© Getty

Ultracool, super-stable and buoyant

© Getty

Seeing inside our bodies

Liquid helium circulates inside magnetic resonance imaging (MRI) machines to produce scans that help doctors see inside patients. The liquid helium cools superconducting niobium-titanium magnets. An MRI machine makes the magnetic field oscillate so that hydrogen atoms in the patient's tissues give off a detectable radio signal.

© Getty

Keeping safe in space

Hydrogen's boiling point is -252.88 degrees Celsius, so helium is able to remain a gas even at the same low temperatures as liquid hydrogen, which is used as rocket fuel. Helium can therefore safely be used to clean out spacecraft engines. In its liquid form, helium is also used to cool down satellite instruments that might overheat.

© Getty

Isolating chemicals

Because helium is so unreactive, scientists don't have to worry about it changing other substances that it comes into contact with. That means it can safely help separate mixtures of chemicals using gas chromatography. It acts like the water that separates ink into different colours when printed paper gets wet.

© Getty

Studying the upper atmosphere

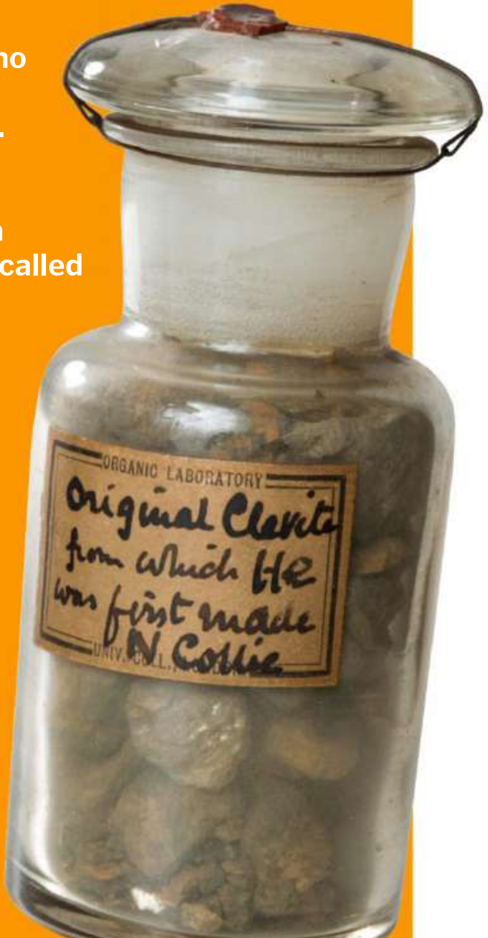
Helium-filled meteorological weather balloons venture into Earth's upper atmosphere every day. At approximately midnight and noon Greenwich Mean Time (GMT), meteorologists release almost 900 balloons at locations around the world. They can swell to five times their original size as the pressure outside the rising balloon decreases.

A gap in the rainbow

19th-century scientists found helium in sunlight using instruments called spectroscopes. These break up light like a rainbow, but much more precisely. Spectroscopes revealed 574 dark lines in the rainbow. In 1859 Gustav Kirchhoff and Robert Bunsen showed some lines exactly matched similar lines found when burning known chemical elements. They realised the lines revealed the Sun's chemical composition.

During a solar eclipse in August 1868, Pierre Janssen saw a line never previously seen. In October the same year, English astronomer Norman Lockyer saw the same line. Both decided it was a new element. Lockyer called it helium after the Greek word for the Sun, helios.

For decades, no one could find helium on Earth. Then, in 1895, William Ramsay detected helium when a mineral called cleveite reacted with acid. The radioactive element uranium had broken down to make helium, which was trapped in the rock but freed by the acid.



Uranium atoms in cleveite minerals break down to make helium

© UCL Mathematical and Physical Sciences Clevite

Running out of gas

You might think we get helium by pulling it out of the air, but actually we suck it out of the ground. Underground stores form very slowly as atoms of large radioactive elements break down, releasing helium gas. Through the 20th century the US government was the world's largest helium supplier, having stockpiled it for use in military balloons. A former gas field in Texas holds enough helium for about 3 billion party balloons. But the US government expects to run out in 2023.

The American Chemical Society therefore calls helium an 'endangered element', and recommends that people don't buy helium party balloons. For now Russia is stepping in to fill the supply gap. However, it's still worth remembering that helium forms on Earth very slowly.

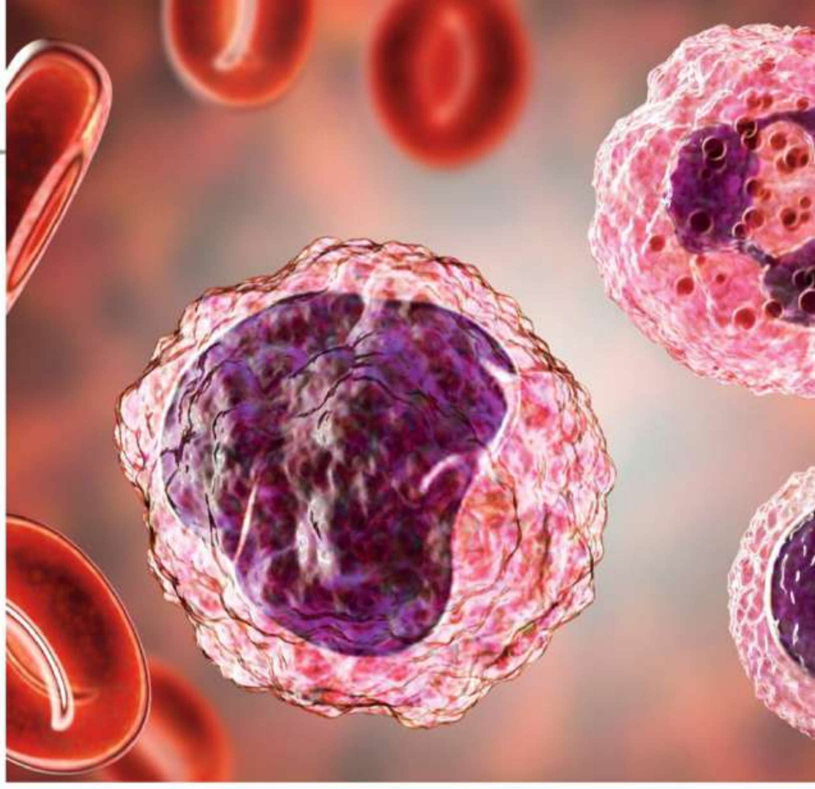
How the body makes blood

This life-supporting fluid is produced within our bones

Beneath our skin, blood circulates our bodies, distributing the oxygen and nutrients we require to stay alive. Although the blood pumping through us is constant, the blood cells that rush through our veins are frequently being replaced. Red blood cells only live for around 120 days, and with the possibility of losing blood unexpectedly in accidents, we routinely need new supplies. Luckily, our bodies have a way of creating plenty more of them.

Red blood cells don't have a nucleus, the part of a cell that controls functions and contains DNA. Without these genetic instructions, red blood cells can't make copies of themselves the same way that other cells do. Instead the body produces entirely new cells. It does this by modifying cells that do not yet have specific roles, called stem cells.

Blood cells are born from bone marrow. This soft, spongy tissue is home to stem cells, which have the potential to become any tissue cells the body needs. As well as producing blood, the body has to maintain and filter the cells it makes. To ensure the right number of cells are pumping through blood vessels, old blood cells that are no longer needed are destroyed. Without this process, the regular manufacturing of blood cells would create blood that is too thick, and the body would be unable to keep it circulating.

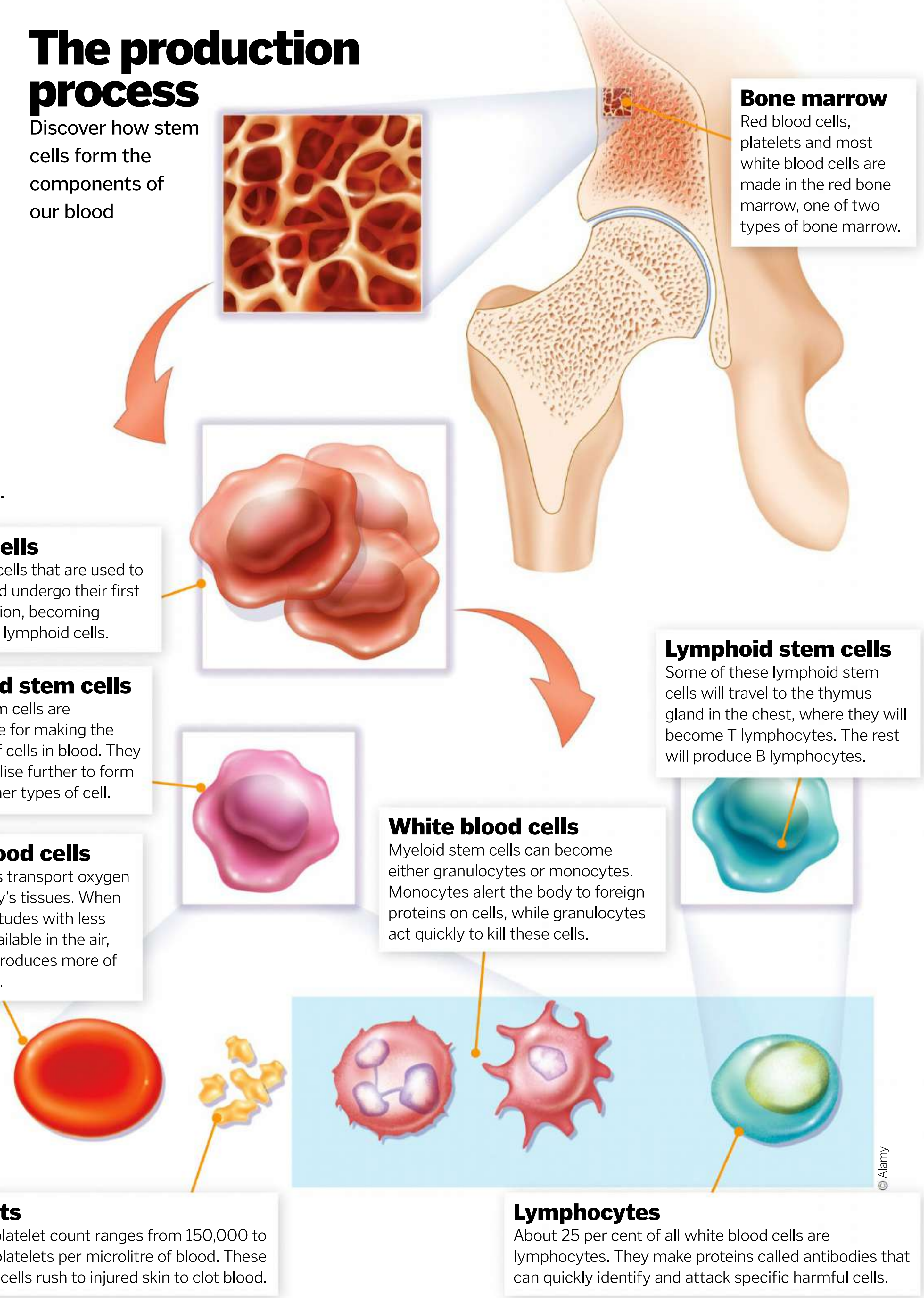


© Getty

Some white blood cells only live for a matter of days, while others stay in the body for years

The production process

Discover how stem cells form the components of our blood



Bone marrow
Red blood cells, platelets and most white blood cells are made in the red bone marrow, one of two types of bone marrow.

Stem cells
The stem cells that are used to make blood undergo their first specialisation, becoming myeloid or lymphoid cells.

Myeloid stem cells
These stem cells are responsible for making the majority of cells in blood. They can specialise further to form several other types of cell.

Lymphoid stem cells
Some of these lymphoid stem cells will travel to the thymus gland in the chest, where they will become T lymphocytes. The rest will produce B lymphocytes.

White blood cells
Myeloid stem cells can become either granulocytes or monocytes. Monocytes alert the body to foreign proteins on cells, while granulocytes act quickly to kill these cells.

Red blood cells
These cells transport oxygen to the body's tissues. When at high altitudes with less oxygen available in the air, the body produces more of these cells.

Platelets
A normal platelet count ranges from 150,000 to 450,000 platelets per microlitre of blood. These colourless cells rush to injured skin to clot blood.

Lymphocytes
About 25 per cent of all white blood cells are lymphocytes. They make proteins called antibodies that can quickly identify and attack specific harmful cells.

© Alamy

5 FACTS ABOUT BLOOD REPLACEMENT

1 Production time
It takes about two days for a red blood cell to be produced.

2 By the millions
2 million red blood cells are produced every second.

3 Donating blood
When giving blood, an adult can donate one of the ten pints in the average adult body.

4 Replacements
It takes the body 48 hours to replace blood plasma and up to eight weeks to replace red blood cells after blood donation.

5 Pregnancy production
When pregnant, the volume of blood in the body can increase by up to 50 per cent, as the body and baby require more oxygen.

Special offer for readers in ***North America***

4 FREE issues

when you subscribe*

“The action-packed science and technology magazine that feeds minds”

FREE 2 eBOOKS 2 POSTERS & WALLPAPERS
INSIDE A SKI CAR
HOW IT WORKS
COULD WE BUILD JURASSIC PARK?
NORTHERN LIGHTS
MOUNT EVEREST
GRAND PRISMATIC SPRING
NATURAL WONDERS
HOW THE MOST SENSATIONAL SIGHTS ON PLANET EARTH CAME INTO EXISTENCE
GIANT'S CAUSEWAY
THE GRAND CANYON
PERITO MORENO GLACIER
WHY DO WE LOVE CATS?
DETECTING DANGERS FROM OUTER SPACE
BATTLEFIELD MEDICINE STAR FACTORIES ALL ABOUT HELIUM SAVING THE SUEZ CANAL
MASS EXTINCTION
CAN WE LIVE FOREVER?
DEADLY RADIATION
HOW TO BUILD A WARSHIP

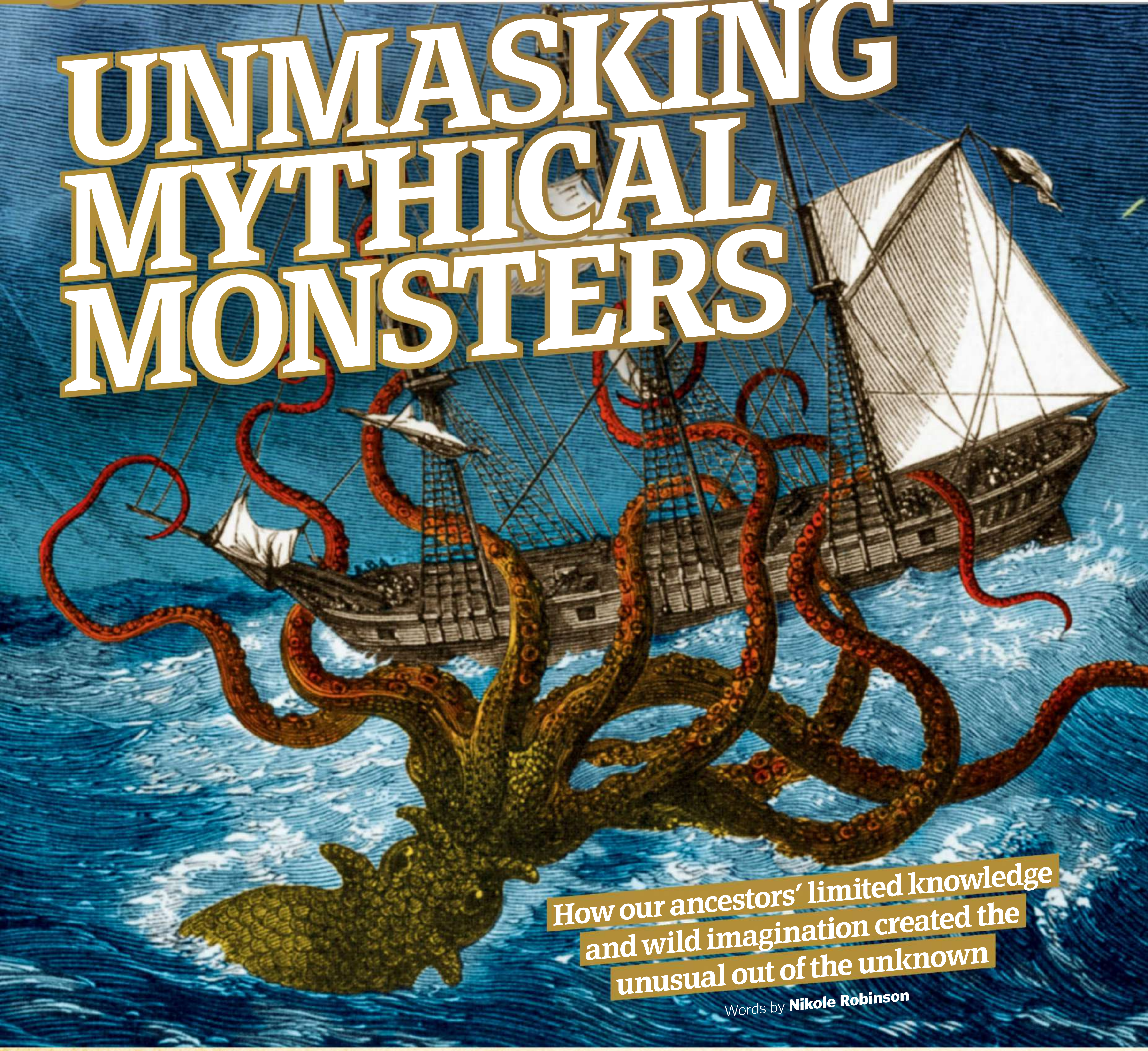
Order hotline **+44 (0) 330 333 1113**

Online at **www.magazinesdirect.com/hiw/79as**

OFFER EXPIRES 30 Jun 2021

***Terms and conditions** Offer closes 30/06/2021. Offer open to new subscribers only. Direct Debit offer is available to UK subscribers only. This price is guaranteed for the first 12 months and we will notify you in advance of any price changes. Please allow up to six weeks for delivery of your first subscription issue, or up to eight weeks overseas. The full subscription rate is for 12 months (13 issues) and includes postage and packaging. If the magazine ordered changes frequency per annum, we will honour the number of issues paid for, not the term of the subscription. For full terms and conditions visit **www.magazinesdirect.com/terms**. For enquiries please call: +44 (0) 330 333 1113. Lines are open Monday to Friday 9am to 5pm UK time or e-mail: **help@magazinesdirect.com**. Calls to 0330 numbers will be charged at no more than a national landline call, and may be included in your phone provider's call bundle.

UNMASKING MYTHICAL MONSTERS



How our ancestors' limited knowledge and wild imagination created the unusual out of the unknown

Words by **Nikole Robinson**

Storytelling is an intrinsic part of human nature. Since we first began to communicate, it's been a way to share our experiences and knowledge with others, but also to frighten, intrigue and entertain. As cultures collided, sharing stories became a way to get to know one another and the legends of the land from which people came. As these stories spread, they changed and grew, often becoming stranger than fiction as they were passed on. To those hearing these tall tales for the first time, however, they might have been taken as fact.

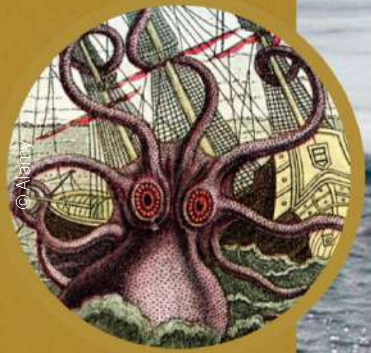
Commonplace in the chronicles of every culture are monstrous beasts and curious creatures. Greek poets wrote of minotaurs in mazes and sirens who serenaded sailors to their deaths. Vikings told tales of trolls and elves as they drank their mead. This is not far removed from the modern day, where these myths and monsters have become entwined with popular culture. Films have vampires waging war against werewolves, while fantasy books feature dwarves and dragon queens. However, there's one major difference: we know that these are purely fantasy, mere fables and fairy tales retold across centuries.

But before modern scientific understanding, some of these creatures seemed very real to those hearing stories about them. To the people of the past, these monsters were more than just legends. They could also be a way to imagine the story of something that couldn't be explained at the time, such as gigantic bones or people disappearing without a trace. When unmasking the mythical monsters of the past, some of them have rather ordinary origins.

© Alamy

DID YOU KNOW? *One possible origin for the phoenix is the colourful golden pheasant*

THE KRAKEN


© Alamy

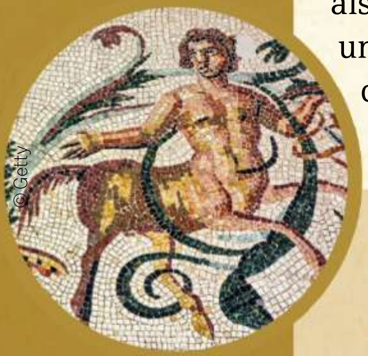
Wrapping its tentacles around a ship, breaking it apart and swallowing the entire crew in one, the kraken was feared by seafarers, with its first appearance in Nordic writings dated around 1180. Sailors spread the story in every port, and soon the beast was feared from Scandinavia through Iceland and all the way to Greenland. To the first navigators, the unknown nature of the sea gave rise to mystery. Sailors likely spotted giant squid and embellished the tale through fear, giving rise to a monster.

Even today there's a lot we don't know about our oceans, and we're not sure how big a giant squid can grow, or how many species there are. Perhaps a kraken really is lurking in the deepest depths…

© Getty

An 8.62-metre giant squid specimen on display at London's Natural History Museum

CENTAUR


© Getty

Horses were first domesticated around 8,000 years ago, and evidence of them being used for transport crops up in Mesopotamian drawings from 2000 BCE. It's believed that the myth of the centaur is grounded in raiders and soldiers on horseback who attacked early non-riding cultures.

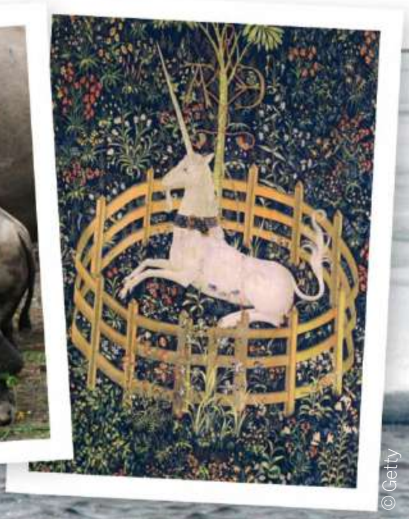
For those that had never been charged at by men on horseback before, this would have been a shock. Their minds may have merged the steed and rider into a monstrous half-human hybrid, or they may have escaped and spread the story to make their encounter sound more terrifying.

© Getty

Raiders riding into battle may have confused communities without horses of their own

© Getty

The horn alone was enough to describe the rhino as a unicorn


© Getty

© Alamy

Narwhal tusks were sold as unicorn horns that held magical properties

UNICORN

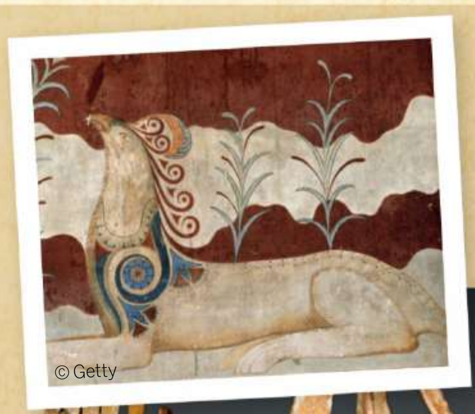
Stories of these elegant equines date back to antiquity, though in ancient Greece they were written as natural history, believed to inhabit far-off India. Drinking from the beast's horn was said to ward off ailments, and they were described as quick and evasive. Later medieval depictions take on some of these qualities, but also stem from Biblical iconography, in which unicorns were rare and beautiful creatures that could only be tamed by a maiden, representing the Virgin Mary. The unicorn's horn continued to be revered for its purifying powers. Trading of narwhal and rhinoceros horns became popular, fooling those who had never seen these creatures.

In the 13th century, explorer Marco Polo encountered rhinoceroses. Since he had no concept of these creatures, his brain linked their one-horned appearance to legends of unicorns. He found they did not compare to the magnificence of tapestries, writing: "'Tis a passing ugly beast to look upon, and is not in the least like that which our stories tell of as being caught in the lap of a virgin."

GRIFFIN

A griffin has the body of a lion, an apex predator on land, and the head of an eagle, a hunter of the skies, combining two powerful beasts into one legendary one. Griffins and their counterparts, such as the Roc and Lamassu, appear across many cultures – some are winged, while others are not. There are many representations in ancient Egypt, Greece and Persia going back thousands of years, but griffins actually date back much further, to the Bronze Age.

Tales grew from the 7th century BCE onwards, when travel to Asia along the Silk Road increased. Griffins inhabiting the Far East were said to lay eggs of gold that made the land there prosperous. This may actually be grounded in some fact: the Mongolian Gobi Desert lies along the Silk Road, and fossils of protoceratops have been uncovered there. Their beak-like mouths may have been mistaken for a griffin's, while fossilised eggs would also fit the myth.


© Getty

© Alamy

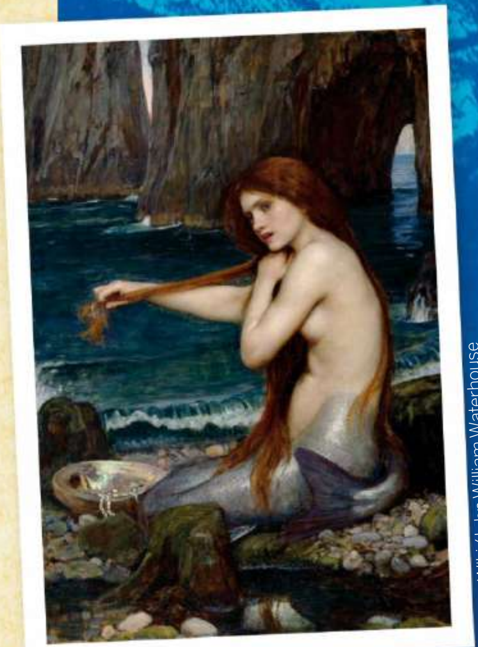
The skull of this dinosaur looks more avian than reptilian thanks to its beak

MERMAID

The first 'mermaid' was the ancient Assyrian goddess of fertility, Atargatis, who tried to take the form of a fish after accidentally killing a human she loved. Roman stories of nereids washing up in Gaul (present-day France) spread later, along with ancient Greek sirens – though originally half-bird, they warped over time into half-fish due to their association with the sea and luring sailors. While many ancient accounts present mermaids as dangerous, able to summon up storms or bring bad luck, there are some stories that present a more romantic or helpful side to them.

As the Age of Discovery began in the 15th century, sailor sightings of mermaids increased, including a record in Christopher Columbus' diary, where he noted they "were not as pretty as they are depicted, for somehow in the face they look like men". In all likelihood the sailors had spotted manatees and dugongs.

Dugongs also populate the waters near Syria, making it possible they could have been the inspiration for Atargatis.

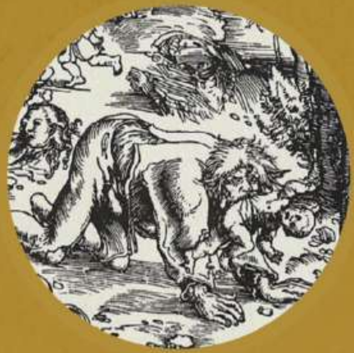


Source: Wiki/John William Waterhouse

To a lonely sailor, perhaps even a sea cow looked beautiful

© Getty

WEREWOLF



Source: Wiki/Lucas Cranach the Elder

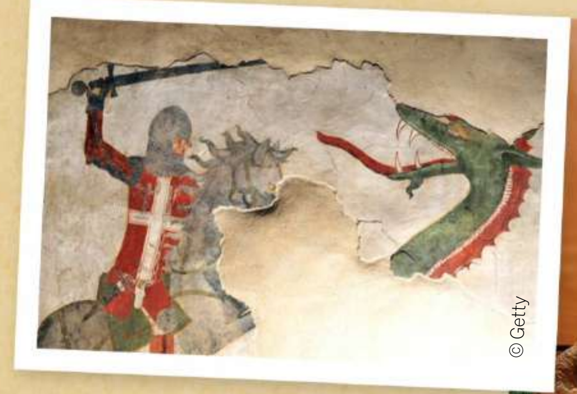
Werewolf myths vary between those who are able to shapeshift into a full wolf and wolf-man hybrids. The first stories of these lupine creatures can be found in Mesopotamian and ancient Greek texts. In some accounts men were turned into wolves as punishment for committing crimes, while in others those cursed were able to turn back as long as they had not feasted on human flesh. Ancient humans probably feared wolves, knowing them to be predators, though in actuality they were unlikely to attack humans unless starving or threatened. Many medieval werewolf attacks were serial killers or cannibals – these inhumane attacks were likely easier for people to accept if the murderers were viewed as monsters. The ripped, bloody clothes of victims would also feed into the transformation myths.

© Alamy

Though unlikely to attack humans, wolves are still perceived as a threat

DRAGON

Dragons arose independently in many different cultures, so draconic depictions differ around the world, especially between the East and West. Chinese dragons appear much more snakelike and are associated with gods and emperors, while European medieval dragons are scaly, winged beasts slain by heroes. However, it's likely that stories stemmed from some of the same origins, since similarities can be found. The earliest unearthings of dinosaur bones in China were thought to be the remains of dragons, with records from 300 CE of historian Chang Qu documenting a find in Sichuan. Giant whale bones found inland were also mistaken for dragons in a time before humans knew about changing sea levels, since not a lot was known about beasts of the deep at this time. A fear of snakes and large predators may also be to blame, since dragons seem to have a mix of the deadliest parts of predators, like poison, sharp teeth and claws. Comets are also thought to have inspired the fiery nature of dragons in some Anglo-Saxon stories, since these fireballs in the sky would have been little understood at the time.



© Getty

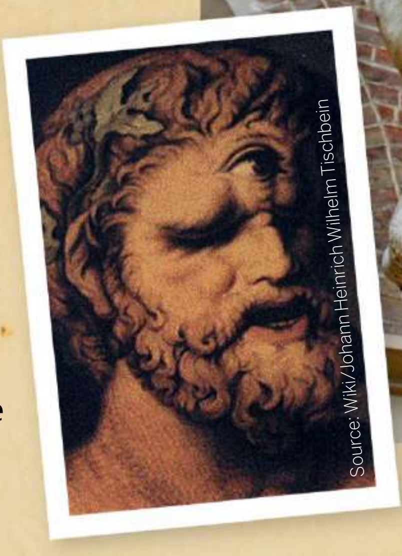
Tyrannosaurus skulls bare a resemblance to Western dragons

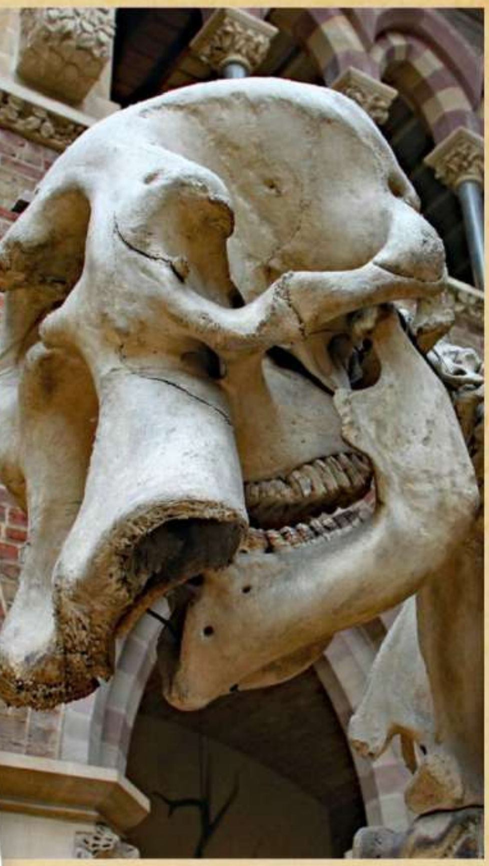
© Getty

DID YOU KNOW? *Gnomes, the subterranean fairy creatures, have become a popular garden decoration since the 1840s*

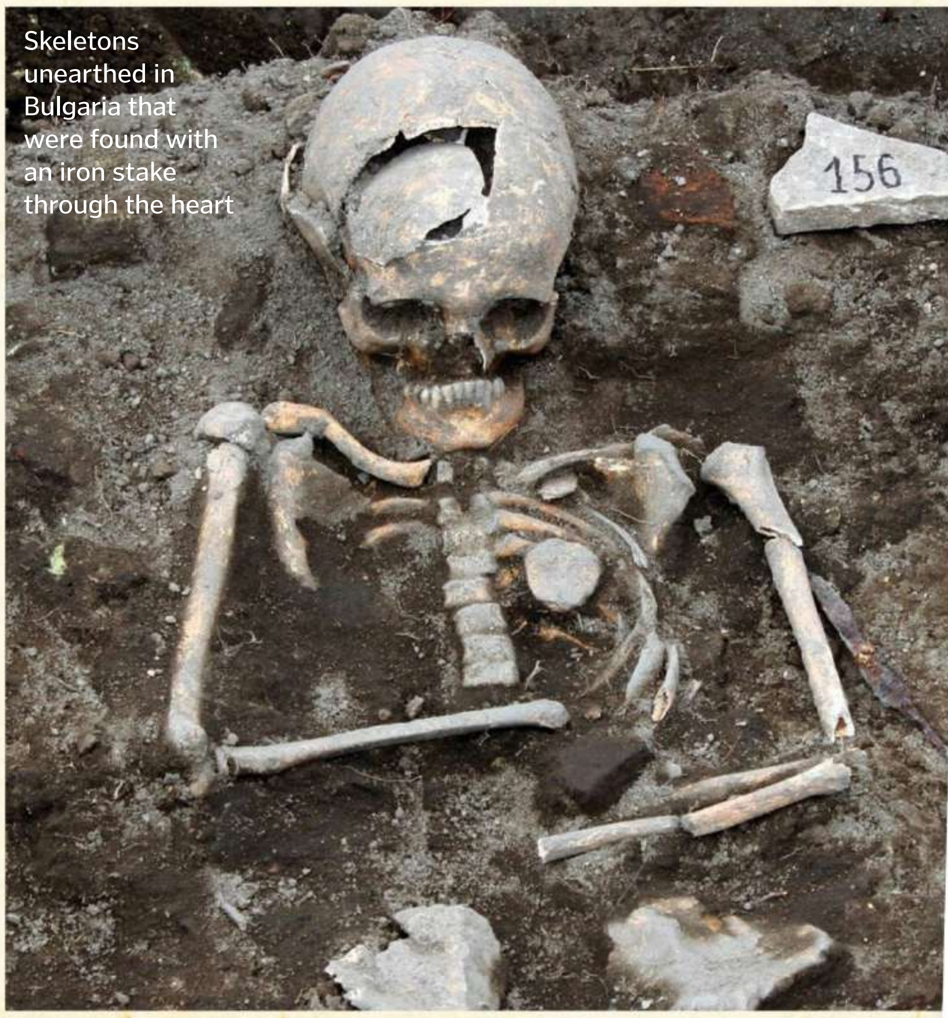
CYCLOPS

Originating in Greek stories of gods and monsters, cyclops translates as 'round eye'. In Hesiod's *Theogony* of 700 BCE, three cyclopean brothers were servants of Zeus, while Homer's *Odyssey* also featured the beasts. In most tales they are humanoid, but of titanic size, and were cannibalistic, with one large eye in the centre of the forehead for which to stare down their human prey. By the 5th century BCE they were thought to inhabit Sicily, just off the 'boot' of Italy. In 1914 Austrian palaeontologist Othenio Abel posited that cyclopes may have sprung from the discovery of fossilised elephant skulls, since the nasal cavity could be mistaken for a large eye socket after the trunk had decomposed away.


Source: Wiki/Johann Heinrich Wilhelm Tischbein


© Alamy

The nasal passage behind the trunk remains as a gaping hole


Skeletons unearthed in Bulgaria that were found with an iron stake through the heart

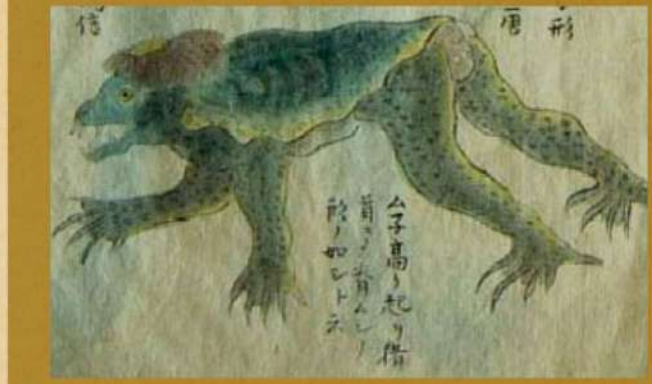
© Getty

Source: Wiki/ Edvard Munch

VAMPIRE

Almost every culture has its own story of a demon or spirit that consumes the blood or flesh of the living, and these vampiric entities have been around in some form for millennia. But the pale, sun-fearing bloodsucker we see today didn't emerge until the 18th century in Southeastern Europe. Belief in vampires increased around this time, causing mass hysteria and the death of many accused, while corpses were nailed down with an iron stake through the heart to prevent them rising from the grave. Early belief likely stemmed from people misunderstanding the slow decomposition of the human body after death, with corpses that remained lifelike thought to be undead. Contagious diseases ripping through populations also gave rise to vampire myths, as well as the blood disorder porphyria, which causes an aversion to sunlight and the recession of gums, which may have been linked to fangs. The sulphur content of garlic could also cause an aversion to sufferers of the disease.

MYSTERIOUS MONSTERS


Source: Wiki/ Rekai/Iwase Bunko Collection

Kappa

Human child sized, but yellow-green with scaly skin and webbed hands and feet, they're often depicted with a turtle shell. Many believe they were thought up to keep children away from bodies of water.

© Alamy

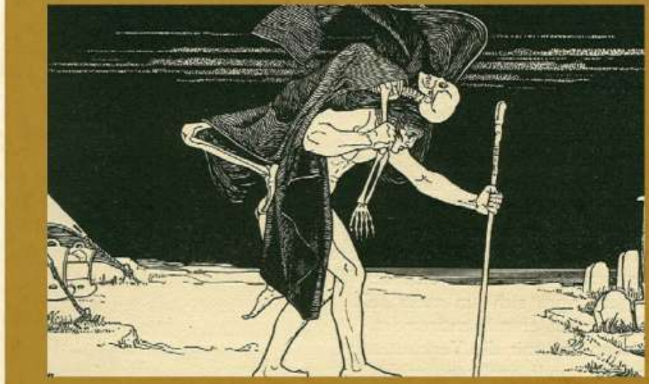
Amarok

A gigantic and vicious Arctic wolf-beast, it stalks anyone who hunts alone at night, devouring them. Inuit legends feature the fearsome wolf, which may have sprung from Eskimo stories of direwolves.

Source: Wiki/ Robert Kenneth Wilson

Loch Ness Monster

Nessie is one cryptid that people believe to exist in the modern age, with much controversy surrounding its existence. Photographs and sonar readings have been taken, but have been dismissed as unreliable.


Source: Wiki/ Ephraim Moses Lilien

Dybbuk

In Jewish mythology, a dislocated soul from someone who has passed away can possess the living, moving on from its host once it has completed its unfinished business or is forced out via exorcism.

FANTASTIC BEASTS AND WHERE TO FIND THEM

Each country and culture has its own legends, though many overlap

> "Some of these creatures seemed very real to those hearing stories about them"

ARCTIC OCEAN
ALASKA (U.S.)
CANADA
NUNNAVUT TERRITORY
ROCKY MOUNTAINS
UNITED STATES
MEXICO
GULF OF MEXICO
CUBA
COLOMBIA
VENEZUELA
PERU
CHILE
ICELAND
NORWAY
FRANCE
SPAIN
MOROCCO
ALGERIA
MAURITANIA
MALI
NIGER
NIGERIA
W
E
S
© Alamy

YKUR
A majestic grey horse, if you mount one it will ferry you to water and try to drown you. Its backwards hooves help tell it apart from a real horse.

DULLAHAN
Sometimes said to be an embodiment of the Celtic god Crom Dubh, a dullahan is a headless rider on a jet-black steed, carrying its head underneath one arm.

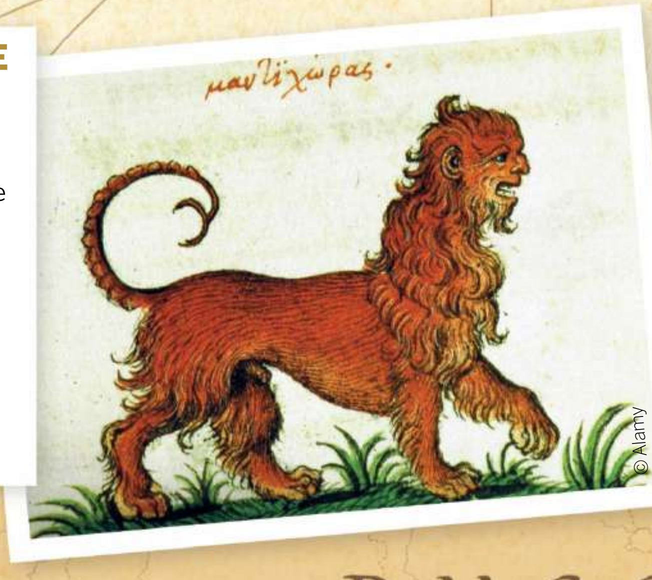
CHUPACABRA
Meaning 'goat-sucker' in Spanish, it is named as such because it drinks the blood of goats. Sightings were reported in Puerto Rico in 1995, and have become more widespread since.

KOBOLD
Usually invisible to humans, these sprites sometimes perform household tasks. However, if they feel slighted, they will play nasty tricks on the people around them.

ADZE
The African vampire enters homes and sucks blood as a firefly. They are said to be able to possess people, negatively influencing those around their host.

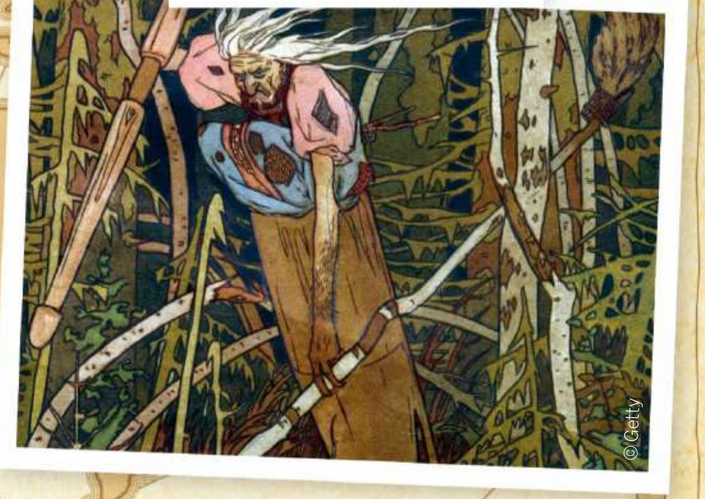
MANTICORE

The Persian equivalent of a sphinx, it has the head of a man, the body of a lion and the tail of a scorpion – or porcupine-like venomous spines. It devours prey whole with three rows of teeth.


© Alamy

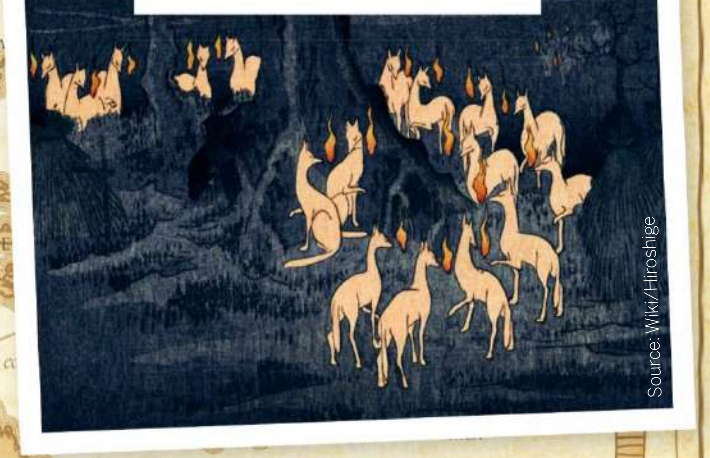
BABA YAGA

A haggard old witch-woman, or sometimes ogress, she lives in a house that walks on chicken legs. Slavic children are often warned she will take them away if they misbehave.


© Getty

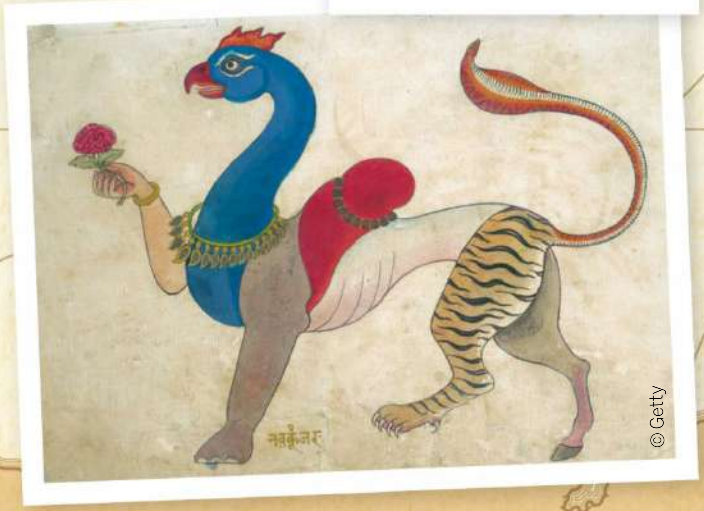
KITSUNE

In Japanese folklore, foxes are said to have paranormal abilities, including being able to shapeshift, which they sometimes use to trick humans. Kitsune can have up to nine tails – the more they have, the wiser they are.


Source: Wiki/Hiroshige

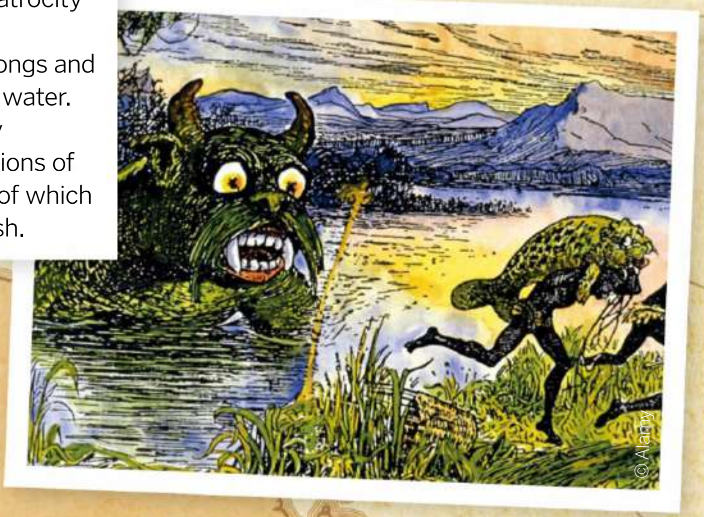
NAVAGUNJARA

This strange chimera is made up of nine animals: rooster, elephant, tiger, deer, peacock, bull, lion, serpent and a human arm. The Hindu god Vishnu once took this as a disguise.


© Getty

BUNYIP

This aboriginal atrocity is said to lurk in swamps, billabongs and other bodies of water. There are many different depictions of this beast, one of which is a giant starfish.


© Alamy

How cats became pets

How a mutually beneficial relationship created one of our favourite pets

Words by **Ailsa Harvey**

Animal domestication often arises from a human decision to take control of another species, but evidence shows that cats became our pets out of a more mutually beneficial arrangement, and they approached us before we were drawn to them. The early stages of the bond between cats and humans began in an area called the Fertile Crescent. Made up of what is today Iraq, Syria, Lebanon, Jordan, Palestine, Israel, Egypt and Turkey, many early civilisations built farms here because of the location's easy access to water.

As agriculture grew, communities found an increased presence of wild cats. These animals were likely hunting the growing number of rodents that had also congregated in the area. As the likes of mice and rats feasted on the farmers' crops, humans welcomed the free pest control that came in the form of felines. Over time, cats became more dependent on people, and people allowed them into their homes.

Some of the first evidence to support this theory was discovered by researchers from China. During an archaeological dig in the Fertile Crescent, they uncovered the remains of animals that were thousands of years old. By studying the composition of nitrogen and carbon in their bones, they were able to determine the age and diet of animals such as rodents, pigs and dogs. This determined that the millet crops known to have been grown there at the time were eaten by many of the animals that resided there. Meanwhile, the cats had mostly eaten rodents that had eaten the millet.

© Getty

Cats are the second most popular pet in the UK

© Getty

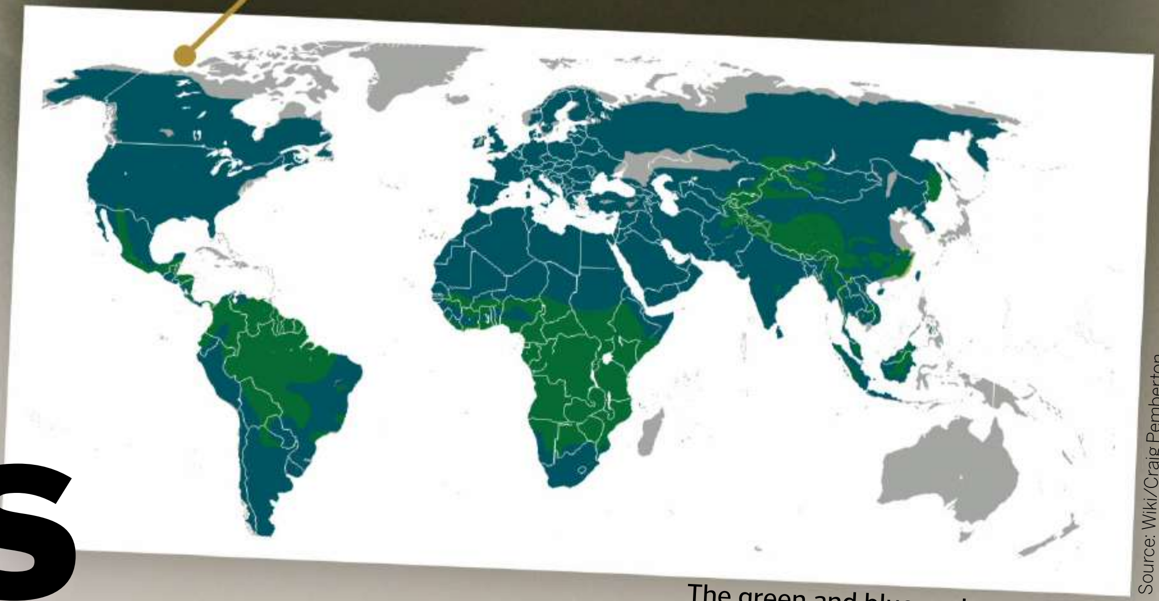
Befriending felines

These creatures have spread across the world alongside humans

10 MILLION YEARS AGO

Felidae family emerges

Between 10 and 12 million years ago, a common ancestor to all of today's cat species roamed. The *Felidae* family of cats are believed to have lived predominantly in Asia before spreading across the continents. All areas of Earth were abundant in cats by around 3 million years ago, except for the Arctic, Antarctica and Australia. This is because of the continual rise and fall of sea level, providing temporary land for the animals to walk across to reach most regions.



The green and blue regions show the areas covered by *Felidae* cats

Source: Wiki/Craig Pemberton

9,500 YEARS AGO

Early signs of human-cat bonds

Ancient burial sites can tell us a lot about what was important to people of the past. One such site in Cyprus appears to display the oldest evidence of cat domestication. In 2004, French archaeologists unearthed a human skeleton lying next to a cat's. Surrounding them were seashells, polished stones and other decorative objects, which may have been laid as an offering.

DID YOU KNOW? *There are around 40 different wild cat species around the world today*

Cats traded in Europe

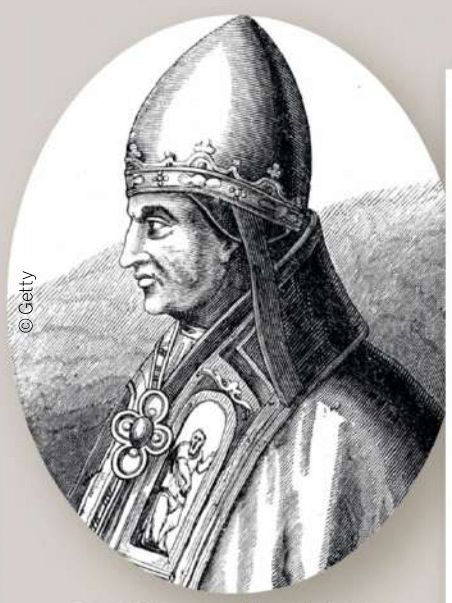
Domestic cats were brought to Europe from Greece and traded. The trade was popular in Rome, where the animal had gained status as a symbol of independence rather than being used to hunt household pests. The Roman army carried cats with them as they travelled, further spreading them across Europe.

Vikings kept cats as pest control, as well using their fur for clothing

© Alamy

Viking cat dispersal

While invading Europe, it's thought that Vikings took some of the cats from Britain that had already been spread to the country by the Roman army. The Vikings were also likely to have been carrying cats with them to keep ships clear of rodents. As they continued their raids, these cats may have been left in Europe.



© Getty

Pope Gregory thought cats could carry the spirit of Satan

Pope Gregory's feline feud

In medieval Europe, people's views of their helpful little pets were soon replaced with fear. Many people at the time believed in witchcraft, and rumours spread that cats were witches' companions. Having associated cats with Satan, Pope Gregory banned the ownership of these animals. Out of fear, many killed cats. This resulted in an increase in the population of rodents and other pests across Europe, which likely helped the spread of the bubonic plague.

4,000 YEARS AGO

3,000 YEARS AGO

1,000 YEARS AGO

700 YEARS AGO

500 YEARS AGO

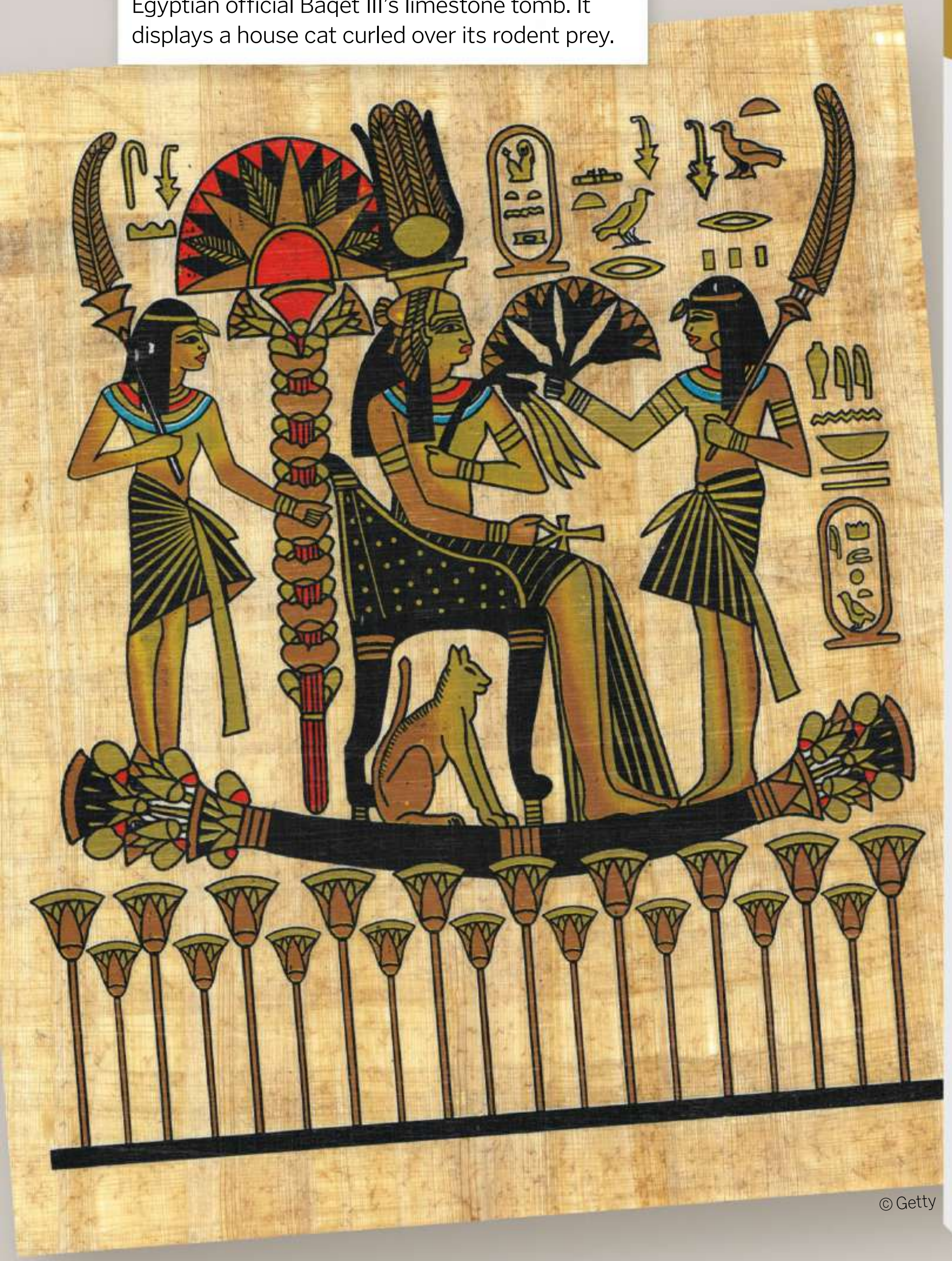
TODAY

Domestication in Egypt

A few thousand years after their domestication in Greece and surrounding areas, cats are thought to have been tamed for a second time in Egypt. They are commonly seen in ancient Egyptian artwork, but the first evidence of a tame cat in these images dates back to around 1950 BCE. Located 155 miles south of Cairo, the painting was found on the wall of ancient Egyptian official Baqet III's limestone tomb. It displays a house cat curled over its rodent prey.

> *"Over time, cats became more dependent on people"*

Ancient Egyptians believed keeping cats as pets could protect their homes



© Getty

5 FACTS ABOUT

CATS BY COUNTRY

1 Egypt Killing a cat in ancient Egypt could result in the death penalty. Many worshipped the goddess Bastet, who was often pictured in cat form.

2 Rome In 400 CE, cats were viewed as sacred animals in Rome. Felines were allowed to walk freely around holy buildings in the city.

3 China In ancient China, cats were viewed as powerful beings. A belief grew that it was possible to tell the time just by looking directly into a cat's eyes.

4 Japan The maneki-neko, or beckoning cat, is a symbol of luck in Japan. The cat with a raised paw represents the ancient story of a cat who is said to have saved the emperor from a lightning strike by calling him over with a raised paw.

5 Greece In ancient Greece they shared the same cat goddess as Egypt. However, they named her Ailuros, the goddess of protection.

Introduction to the West

Throughout the 1500s, cats began to return as companions, and the church stopped associating cats with the devil. By the 1600s, cats were able to thrive across Europe again. As colonists travelled from Europe to North and South America, they brought cats with them to assist in land cultivation and pest control. These were the first documented domestic cats in America.

Domestic cats still present traits from their wild ancestors, such as playing with prey and defending their territory

The modern cat

With domestic cats spread across the globe, today there are more than 373 million of them living as pets. This number makes up a huge proportion of the 400 million total cats on the planet. Cats are still worshipped and admired in some areas of the world. For example, in Islam cats are viewed as clean, sacred animals. Istanbul has over 125,000 free-roaming cats, and citizens line the streets with water and food to care for them.

© Getty

★ ON SALE NOW! ★

Take control of your mind for a happier, healthier life

Understanding human behaviour and mental processes can be invigorating. Why do we feel certain emotions in specific situations? Why do we behave in particular ways? And what can we do to overcome the things that hold us back? Delve into the world of psychology and build a better relationship with your mind.

NEW
VOLUME 3
Psychology Now
TAKE CONTROL OF YOUR MIND FOR A HAPPIER, HEALTHIER LIFE
"THE MAJORITY OF PEOPLE AREN'T RACIST, BUT BEING ANTI-RACIST IS VERY DIFFERENT"
Exclusive
KELLE BRYAN
ON WHY WE MUST TALK MORE ABOUT RACISM
132 pages OF EXPERT ADVICE
THE VIRUS, THE VACCINE & THE ANTI-VAXXERS
THE SCIENCE Behind Love
+ UNDERSTAND NARCISSISM
STOP TRYING TO BE PERFECT
BREAK BAD HABITS FOR GOOD
DISCOVER THE benefits of ADULT PLAY
PSYCHOLOGY NOW VOLUME 3
ISBN 978-1-80023-212-9

Ordering is easy. Go online at:

WWW.MAGAZINESDIRECT.COM

Or get it from selected supermarkets & newsagents

WIN!

A NANOLEAF BUNDLE

This month we are giving you the chance to win a Nanoleaf bundle including a nine-panel Hexagon Starter Kit and a Triangle Expansion Pack. Nanoleaf is an interactive lighting system that lets you choose from millions of colour combinations. These light panels are app or touch-controlled and can also change colours along with the rhythm of your music.

WORTH £229.98

For your chance to win, answer the following question:

Which of these is the largest ocean on Earth?

a) **Pacific Ocean** b) **Indian Ocean** c) **Southern Ocean**

Enter online at **howitworksdaily.com** and one lucky winner will win!

Terms and Conditions: Competition closes at 00:00 BST on 3 June 2021. By taking part in this competition you agree to be bound by these terms and conditions and the Competition Rules: www.futuretcs.com. Entries must be received by 00:00 BST on 03/06/2021. Open to all UK residents aged 18 years or over. The winner will be drawn at random from all valid entries received, and shall be notified by email or telephone. The prize is non-transferable and non-refundable. There is no cash alternative.

BRAIN DUMP

Because enquiring minds need to know...

MEET THE EXPERTS

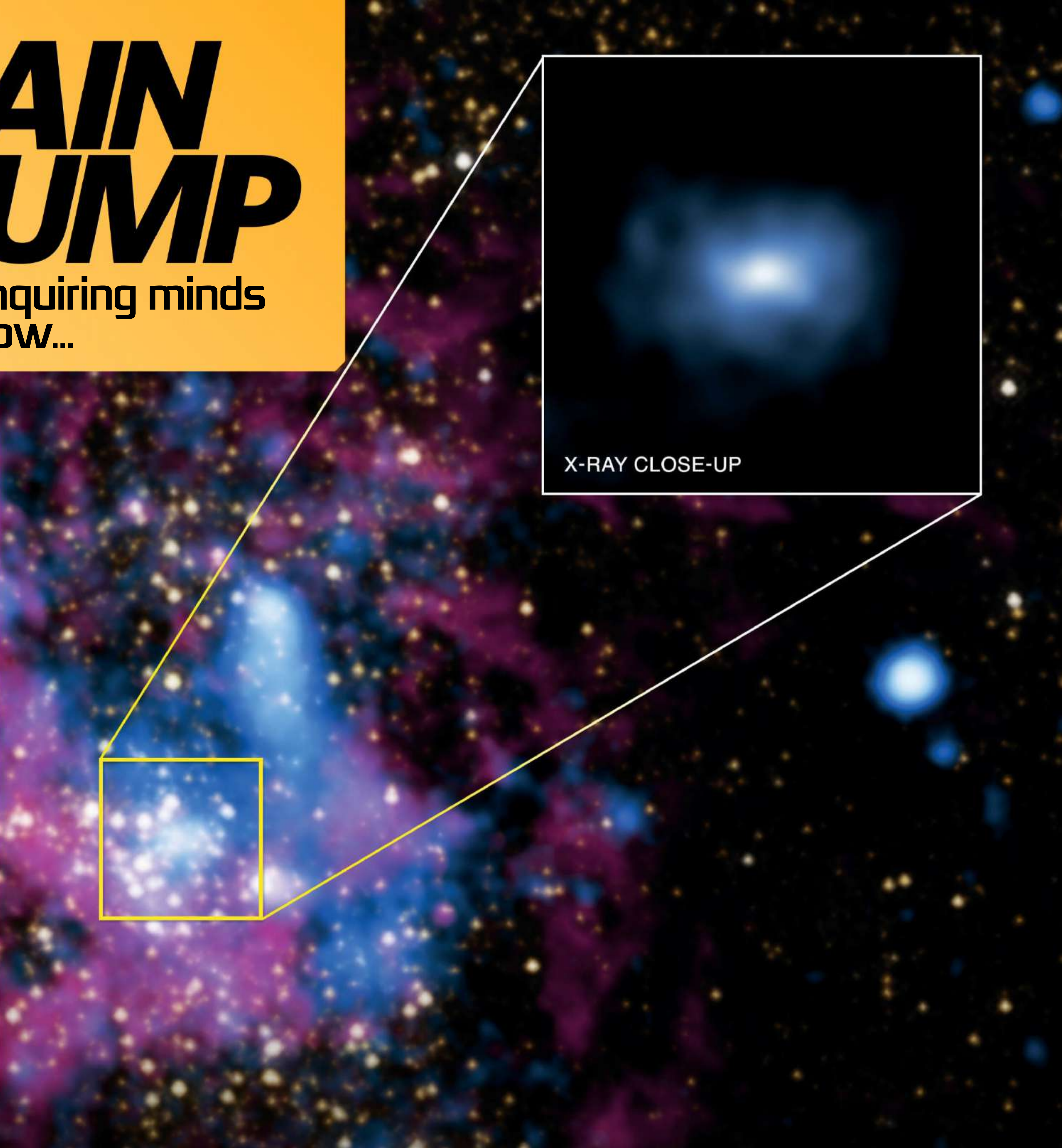
Who's answering your questions this month?

JO ELPHICK

LAUREN EYLES

ANDY EXTANCE

ANDREW MAY



The vicinity of the galaxy's central black hole in a combined X-ray/infrared telescope image

SPACE

Are we being sucked into the black hole at the centre of the Milky Way?

Bryan Green

■ As exotic as they sound, black holes only interact with other matter via ordinary gravity. The reason they can be so destructive is because due to their small dimensions, their gravity becomes enormously strong at short distances. But at large distances, such as the distance Earth is from the centre of the Milky Way, the black hole's gravity is really very weak. It's exactly the same as it would be if the core of the galaxy was made of ordinary stars of the same total mass as the black hole, so there's zero chance of us being sucked in. **AM**

WANT ANSWERS? Send your questions to... How It Works magazine @HowItWorksmag @howitworks@futurenet.com

© NASA

ENVIRONMENT

Were the first living things plants or animals?

Tao Sung

■ Earth used to be very different to all the life that we see today. It's believed the very first life forms were microbial mats called 'stromatolites' – rocky structures created by living microorganisms 3.4 billion years ago. Plant species like algae showed up next, followed by animals. **LE**

© Getty

DID YOU KNOW?

Farmers may be able to hear their crop's need for water in future

© Getty

SCIENCE

Will growing a beard keep you warmer?

Andrew Blume

■ Recent studies from China have proven that bearded men have a facial heat increase of up to three degrees Celsius by trapping body heat, protecting them from the elements. **JE**

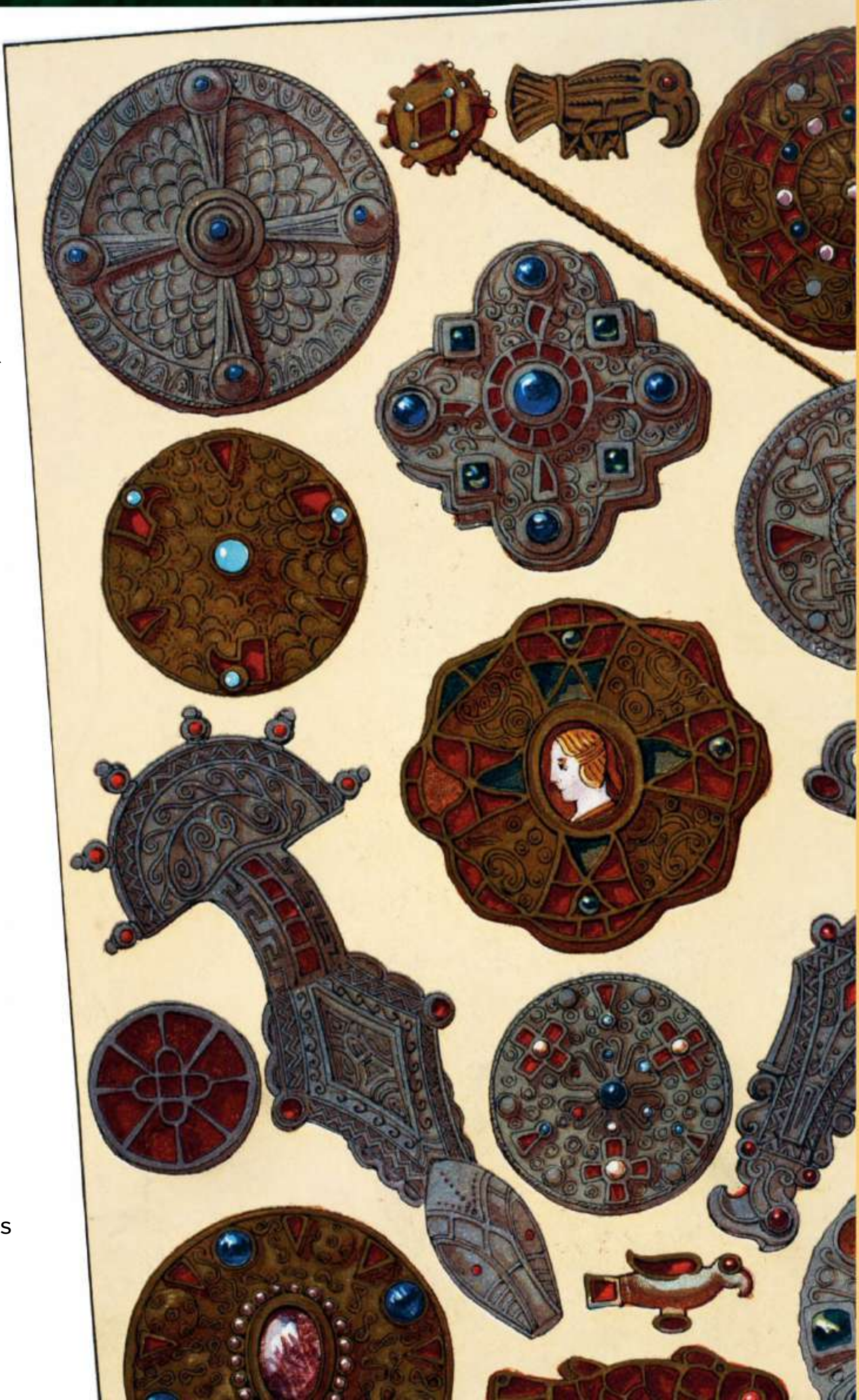
HISTORY

Why is it called the 'Dark Ages'?

Toby Garner

■ The Early Middle Ages, or 'Dark Ages', occurred between the 5th and 10th centuries. The term refers to the perceived lack of culture and scientific advancements compared to those of the Roman Empire.

Whereas Roman historians kept detailed records of their progresses, little was thought to have been written down during this time. Information was shared through song and epic storytelling which was lost in the mists of time – therefore it's said to be a 'dark' period in history. **JE**



© Getty

Contrary to popular belief, many beautiful objects were created during the Dark Ages

© Getty

Glasses and windows are designed to let light through in very different ways

SCIENCE

Why do the glasses on my head correct my vision, but looking through the window doesn't?

Jeff Jacobs

■ Our eyes have lenses at their front that focus light on the retinae at their rear. Their lenses bend light to get a sharp image no matter whether we're looking close or far away. Spectacles' glass lenses are specially shaped to bend light to correct for flaws in our eyes' lenses. Windows today are usually designed so light passes through without bending. Older, uneven window panes sometimes bend light and make the outside look wobbly. **AE**

The Cassini mission lasted nearly 20 years and landed a probe, Huygens, on the surface of Titan

© NASA

SPACE

Could Titan potentially harbour life?

wtorrell1 (Instagram)

■ While there is no evidence of life there, scientists discovered a hidden ocean underneath Titan's icy surface after NASA's Cassini spacecraft returned data on the moon while in orbit around Saturn in 2012. This liquid water, 35 to 50 miles below the surface, puts Saturn's moon on the list of worlds that could potentially support life. On Titan there are also liquid methane and ethane lakes and rivers. These unique environments could be habitable for some forms of life, but these would be entirely different to the life we know on Earth. **BB**

DID YOU KNOW?

NASA's New Horizons spacecraft took nine years to fly to Pluto

© Getty

ENVIRONMENT

Could there be life beneath the Earth's crust?

Monika Netolická

■ It's hard to imagine that anything could live under the Earth's crust, as it's hot, dark and there's very little oxygen. But scientists have found that life does exist in the volcanic rocks of the lower crust. **LE**

© Alamy

SCIENCE

Are electron microscopes more powerful than the Hubble Space Telescope?

Alyssa Holland

■ In terms of magnification, yes. Hubble's effective magnification is a few thousand, while a scanning electron microscope can achieve ten million or more – but they do completely different jobs. **AM**

© Getty

ENVIRONMENT

Why can't gills take oxygen out of the air?

Fahad Amar

■ Gills need water to successfully get oxygen for an animal to breathe. If out of water, the gills crumble, dry up and the animal suffocates. But there are always exceptions to the rule, and some fish have adaptations that allow them to spend time out of water. This ranges from special skin that acts like gills to extra organs that help to receive oxygen from the air. Mudskippers are really well adapted. They spend most of their time out of water by holding bubbles of water inside their gill chambers. This allows them to carry on breathing through their gills while on land. **LE**

ENVIRONMENT

Why can't freshwater creatures live in the sea, and vice-versa?

Marie Mikaelsen

■ Animals living in the sea have really high levels of salt in their bodies, which in freshwater would cause their cells to swell and die. Freshwater animals can't tolerate high salt levels, and the water inside their bodies would flow out of their cells if they entered this environment, also leading to death. But there are animals that have adapted to switch between them both – called 'euryhaline' – such as salmon, bull sharks and green crabs. **LE**

Salmon change into 'smolts', which allows them to journey from the river to the ocean

© Getty

DID YOU KNOW?

Most dinosaurs were actually smaller than a human

HISTORY

Would we still have dinosaurs today if an asteroid hadn't hit Earth 66 million years ago?

Kimberley Brownlow

■ Palaeontologists have argued that the dinosaurs were already in decline long before the asteroid hit Earth, and would therefore have died out irrespective of a meteorite strike, but recent research suggests otherwise.

These creatures had already been highly adaptable throughout 160 million years of climate change, and therefore had further evolutionary potential. Global warming instigated an expanding rainforest, which would have sped up the breeding process of the long-necked dinosaurs. As a result the species would probably have decreased in size, while mammal-like creatures were already developing before the asteroid strike, so they would have continued to do so alongside the dinosaurs. **JE**

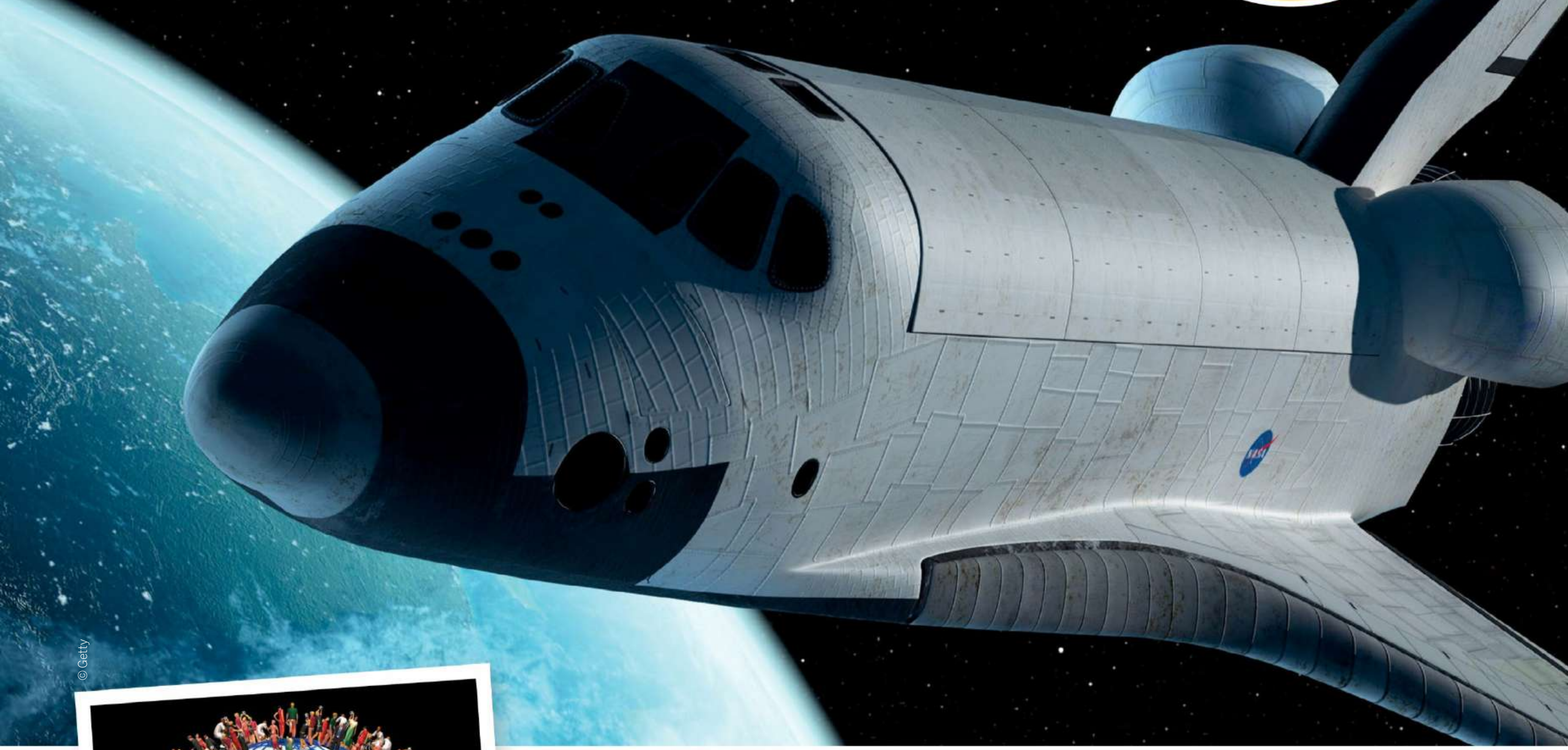
© Getty

SPACE

How long can a spaceship fly for?

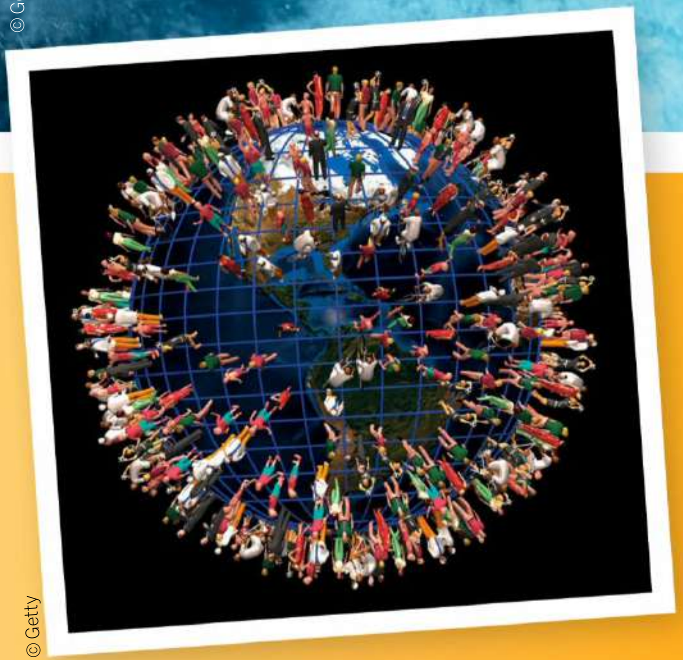
Henry Zhou

Once in space, there's no air resistance to slow a spacecraft, so it can cruise at constant speed indefinitely. To change course it has to fire its rocket engines for a few seconds at a time, so its practical endurance is set by the amount of fuel it can carry. **AM**


© Getty

DID YOU KNOW?

Sponges were one of the first animals to appear Earth

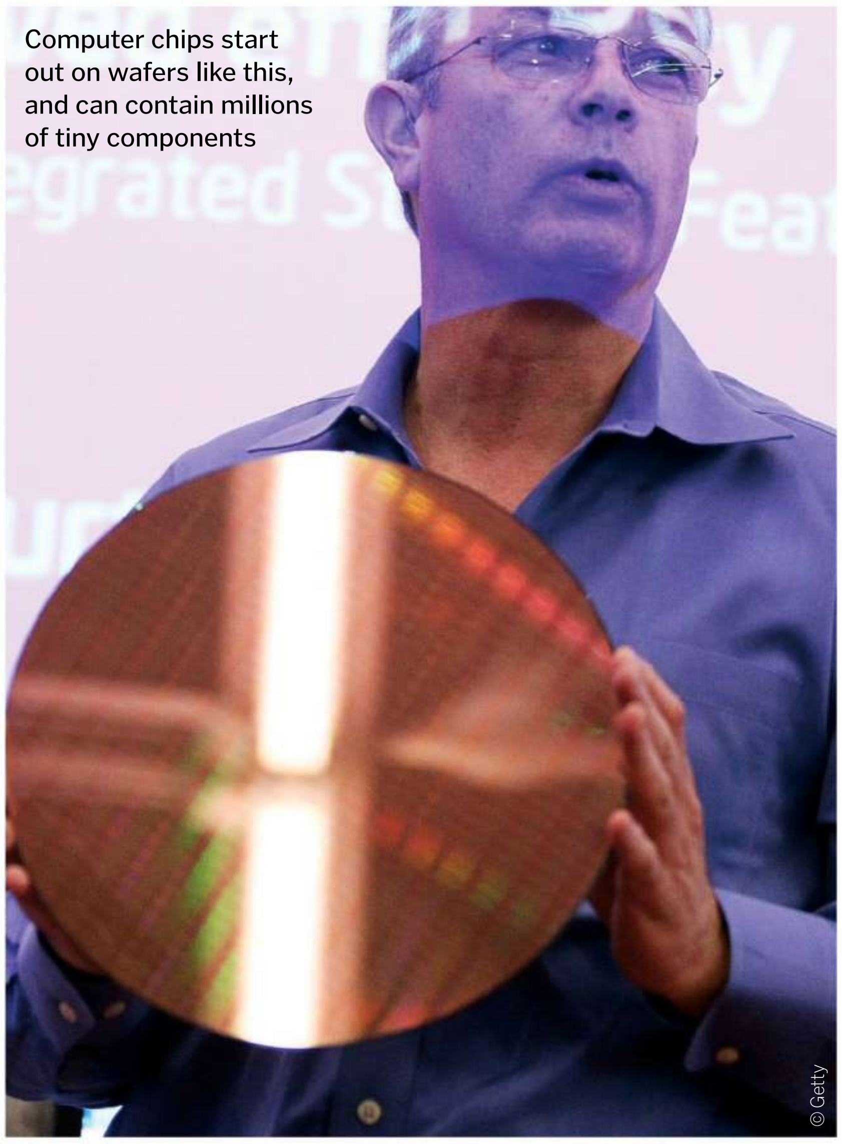

© Getty

SCIENCE

How small can a population be and still remain healthy?

Ella Ashfield

Inbreeding, evolutionary challenges and random events must all be taken into account in order to stay healthy and viable. However, the basic 50/500 rule suggests that a minimum population size of 50 would combat inbreeding, while a minimum of 500 individuals is needed to reduce genetic drift. **JE**


Computer chips start out on wafers like this, and can contain millions of tiny components

© Getty

TECHNOLOGY

Could a computer chip wear out over time and use?

Bill Douglas

Computer chips are made from thin wafers of silicon, sliced into tiny pieces. They rely on intricate circuit patterns, with millions of parts called transistors fitting in a space the size of a full stop. Chips are continuously doing calculations to perform processes, like making images appear on screens. That makes them get hot, and if they heat up too much they can get damaged. The design of some types of memory chips also means that they wear out from use. Also, bizarrely, high-energy particles from space can sometimes pinball other particles into computer chips and cause errors. **AE**

© Getty

ENVIRONMENT

Can any plants make sounds?

@sammy.glanfield (Instagram)

■ Research conducted in 2019 revealed that some plants do make sounds, albeit in an ultrasonic range of 20 to 100 kilohertz. These sounds occur because of cavitation – small vapour-filled cavities – that form in the plant, and happen more frequently when a plant is stressed by a lack of water or when it's been cut. The study only used tomato and tobacco plants, though preliminary studies showed other species made the same sounds. **BB**

© Alamy

The habitable zone is the narrow band around a star where liquid water can exist

SPACE

How far away from the Sun would our orbit have to be for it to make a difference to life on Earth?

Keira Macfarlane

■ The habitable zone, where the temperature is suitable for life, extends from around 0.99 to 1.7 times the Earth's current distance from the Sun, so moving inwards, making the planet hotter, is the dangerous thing. Going the other way, our orbit could become significantly bigger without ruling out the theoretical possibility of life. In practice, however, it would probably start to feel too cold if we were a few per cent further out. **AM**

DID YOU KNOW?

Dark hair will absorb more heat from the Sun

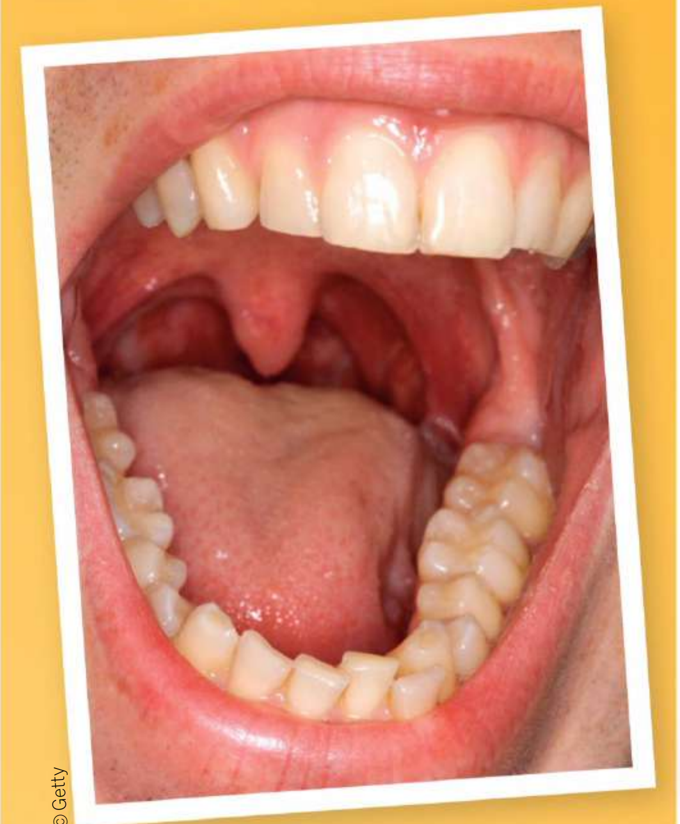
© Getty

TRANSPORT

Why do I sometimes see liquid dripping out of a car exhaust? Is it petrol?

Bethany Winter

■ As engines burn petrol or diesel, the fuel reacts with oxygen to make carbon dioxide and water. When the engine stops and cools down, this water condenses and drips out of the exhaust. **AE**



© Getty

SCIENCE

What causes bad breath?

Aden Hassan

■ Bad breath is mostly caused by bacteria breaking down food residue in your mouth and saliva to make smelly chemicals. By degrading proteins in saliva, mouth bacteria make around a dozen different bad-smelling chemicals. Some of these contain the element sulphur, which is notorious for its stink. **AE**

BOOK REVIEWS

The latest releases for curious minds

Antarctica: a Continent of Wonder

JOURNEY ACROSS THIS ICY CONTINENT WITHOUT LEAVING HOME

ANTARCTICA
A Continent of Wonder
Mario Cuesta Hernando
Raquel Martín
PRESTEL

- Author: **Mario Cuesta Hernando**
- Publisher: **Prestel**
- Price: **£14.99 / $19.95**
- Release: **Out now**

Antarctica is one of the most hostile places to human life on the planet, with temperatures that can be low enough to freeze carbon dioxide out of the air and barely any plants or animals to speak of. It's probably why Antarctica is such a fascinating place to us: the few species that call this huge and chilly continent home are extremely specialised, and apart from a few scientists who stay just months at a time to study the place, humans have never inhabited it. The air is clear, the land is untainted and the wildlife is relatively untouched.

That's not to say we shouldn't go on a tour of this beautiful, wild land, and it's even better that author and explorer Mario Cuesta Hernando is taking us along with him in this fantastic illustrated guide. We travel from Cape Horn to the frozen Antarctic coastline, across the ice to a research station where we stay for one winter before we return. On our travels we make a pit stop to peek beneath our icebreaker ship and discover an astonishing host of underwater sea creatures that thrive in the Antarctic Ocean, including sea spiders, sponges and starfish that have been encased in an underwater ice stalactite. We meet a variety of whales, seals and birds that live in and around the wild seas despite their warm blood, before we head inland to the research station at the South Pole.

Although the southern polar lights – the aurora australis – are an incredible sight and the Antarctic winter is awesome to behold, the highlight of our trip is Mount Erebus, an active volcano nearly 2.4 miles high with a lava lake in the caldera at its summit.

> *The illustrations are wonderfully detailed and evocative*

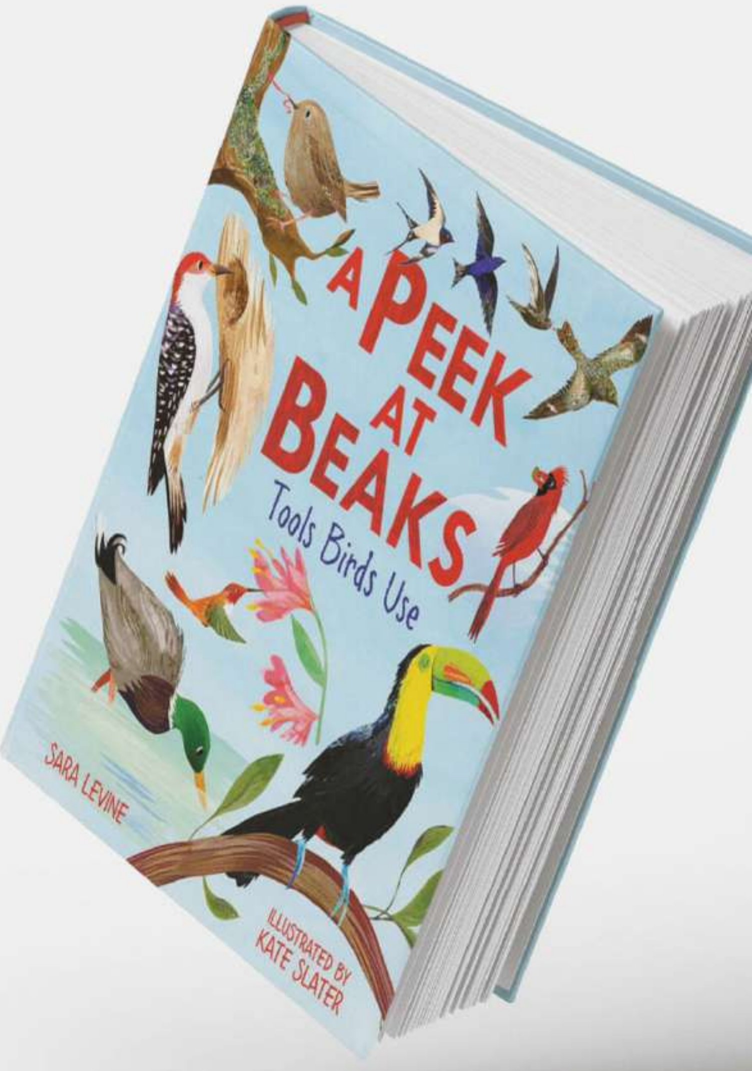
Hernando then leads us back home with ancient histories of the icy southern continent and tales of Antarctica's first human explorers, as well as a word of warning to humanity about the pronounced effect that global warming is having on the ice here. Raquel Martín's illustrations are wonderfully detailed and evocative, and we've learned a lot on our adventure to the bottom of the planet.

A Peek at Beaks

LEARN ALL ABOUT THE NATURAL TOOLS ON THE FACES OF BIRDS

- Author: **Sara Levine**
- Publisher: **Millbrook Press**
- Price: **£14.50 / $19.99**
- Release: **7 September 2021**

What is the purpose of a bird's beak? Each species has one of these convenient tools sticking out from their heads, and if we look closely at their shape and design we can learn about the lifestyles of these birds. Where do they live and how do their beaks help them survive there? This picture book cleverly compares different beaks to human tools, helping children to understand their unique purposes. Each beak type is introduced by ingenious illustrations and a question, allowing the reader to first wonder 'what kind of bird has a beak that works like a jackhammer?' or 'which has a beak like a net?' before revealing the answer. Going beyond the obvious species, *A Peek at Beaks* incorporates a perfectly diverse range. Next time you look at a bird, you won't see a funny pointed nose, but a knife, an air conditioner or even a takeaway service.



Running Smart

RUNNING SMART
How Science Can Improve Your Endurance and Performance
MARISKA VAN SPRUNDEL
translated by Danny Guinan

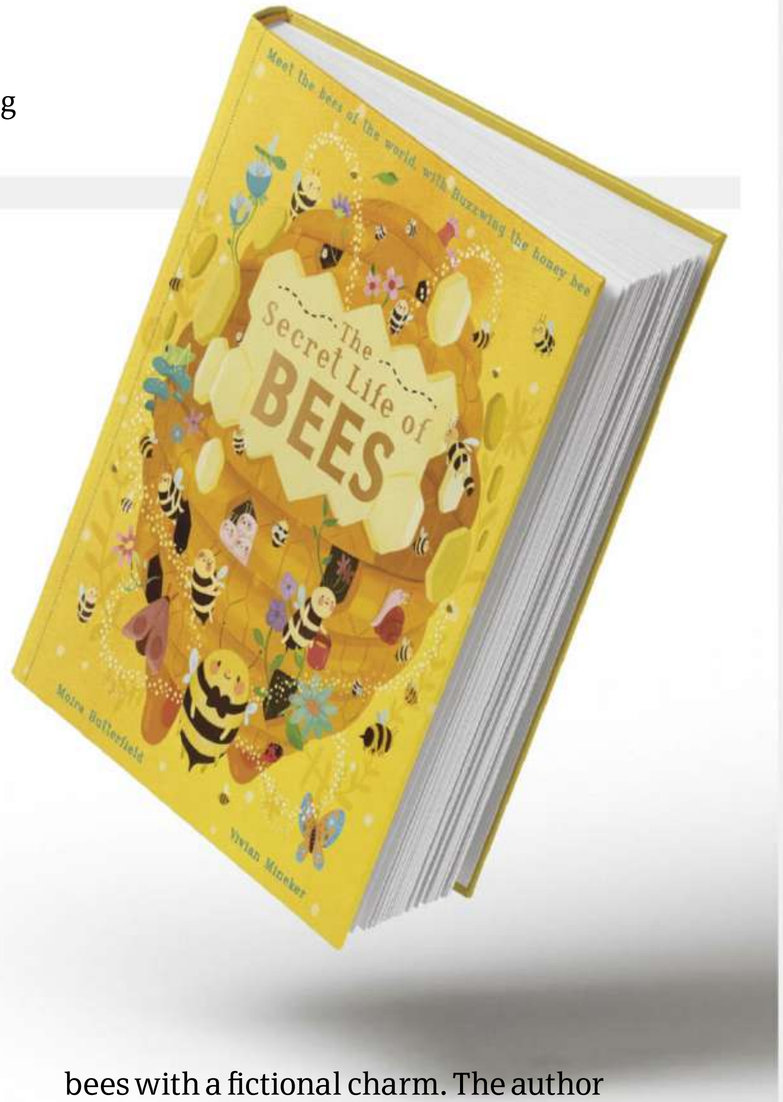
IMPROVE YOUR ATHLETIC PERFORMANCE WITH THE POWER OF SCIENCE

- Author: **Mariska van Sprundel**
- Publisher: **MIT Press**
- Price: **£19.98 / $20.99**
- Release: **14 September 2021**

If you love running, it's likely you've asked yourself how you can do better. Whether you want diet tips for optimal performance or to learn the science behind speed, this book provides you with answers backed with both scientific research and personal experience. Science journalist and runner Mariska van Sprundel unpicks the true science from the many faulty claims surrounding the sport.

From ancient history to modern athletics, *Running Smart* covers the fundamental stages that have defined the movement of running. It explores how our species' transition to upright walking could be the root cause of common injuries, while also providing the crucial anatomical changes that add strength and style. The book also investigates how technological advancement and studies have allowed for effective prosthetic running blades and running shoes. How does this technology absorb the shock waves that travel through your body? How can you find your perfect trainers, and why do some athletes believe they do more harm than good? By explaining the impact of running on your body – both positive and negative – analysing training methods, sport psychology and much more, the information inside is a step towards enhancing your performance.

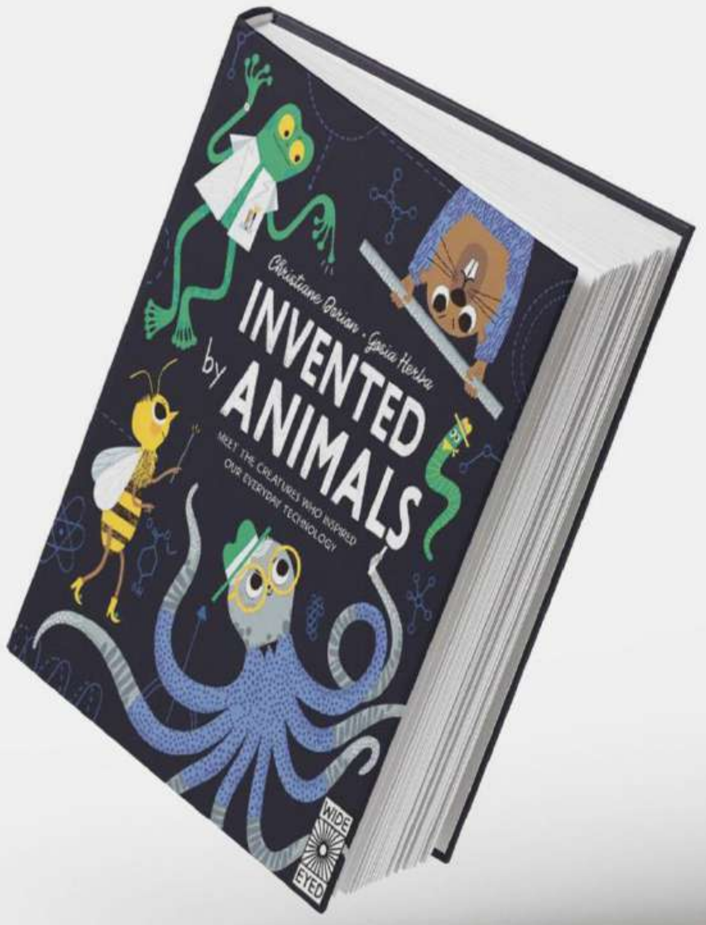
The Secret Life of Bees



MEET THE BEES OF THE WORLD WITH BUZZWING THE HONEY BEE

- Author: **Moira Butterfield**
- Publisher: **Words & Pictures**
- Price: **£12.99 / $19.99**
- Release: **Out now**

From what lies inside a hive to adventures beyond its walls, this book follows a knowledgeable worker bee called Buzzwing as it explores what everyday life is like for these insects. This book is buzzing with information about all aspects of bee life, such as how bees collect pollen and produce and store honey to how they communicate with one another and the other animals they interact with. Simple and fun to follow, it tells the story of bees with a fictional charm. The author occasionally ventures into the imaginary with some fictional bee-themed tales, showcasing how these tiny insects have made their way into literature from around the globe, such as in Greece, India and Thailand.


Christiane Dorion • Gosia Herba
INVENTED by ANIMALS
MEET THE CREATURES WHO INSPIRED OUR EVERYDAY TECHNOLOGY
WIDE EYED

Invented by Animals

MEET THE CREATURES THAT INSPIRED OUR EVERYDAY TECHNOLOGY

- Author: **Christiane Dorion**
- Publisher: **Wide Eyed Editions**
- Price: **£14.99 / $22.99**
- Release: **Out now**

What stands out about this book is the sheer number of examples within. You might have made the connection between bats and sonar or the bird muses of the aviation industry, but did you know that dogs helped develop Velcro or that kingfishers played a part in the creation of the bullet train? The book also looks at technologies that are still being developed in the laboratory, such as lightweight body protection that's been inspired by the tail of a seahorse. Full of interesting information about the animals behind the inventions, this beautifully illustrated book has obviously been created for a young audience. However, the whole family might be surprised by how the study of wildlife has led to everyday technology.

Did you know that dogs helped develop Velcro?

BRAIN GYM

GIVE YOUR BRAIN A PUZZLE WORKOUT

QUICKFIRE QUESTIONS

Q1 The longest known earthworm was:
- ○ 10.8 metres
- ○ 6.7 metres
- ○ 88 centimetres
- ○ 4.2 metres

Q2 In what year did Alexander Fleming discover penicillin?
- ○ 1755
- ○ 1092
- ○ 1900
- ○ 1928

Q3 Why is the sky blue?
- ○ Because sunlight reflects off the blue ocean
- ○ Blue light is scattered more easily
- ○ Sunlight is blue
- ○ Algae in the sky is blue

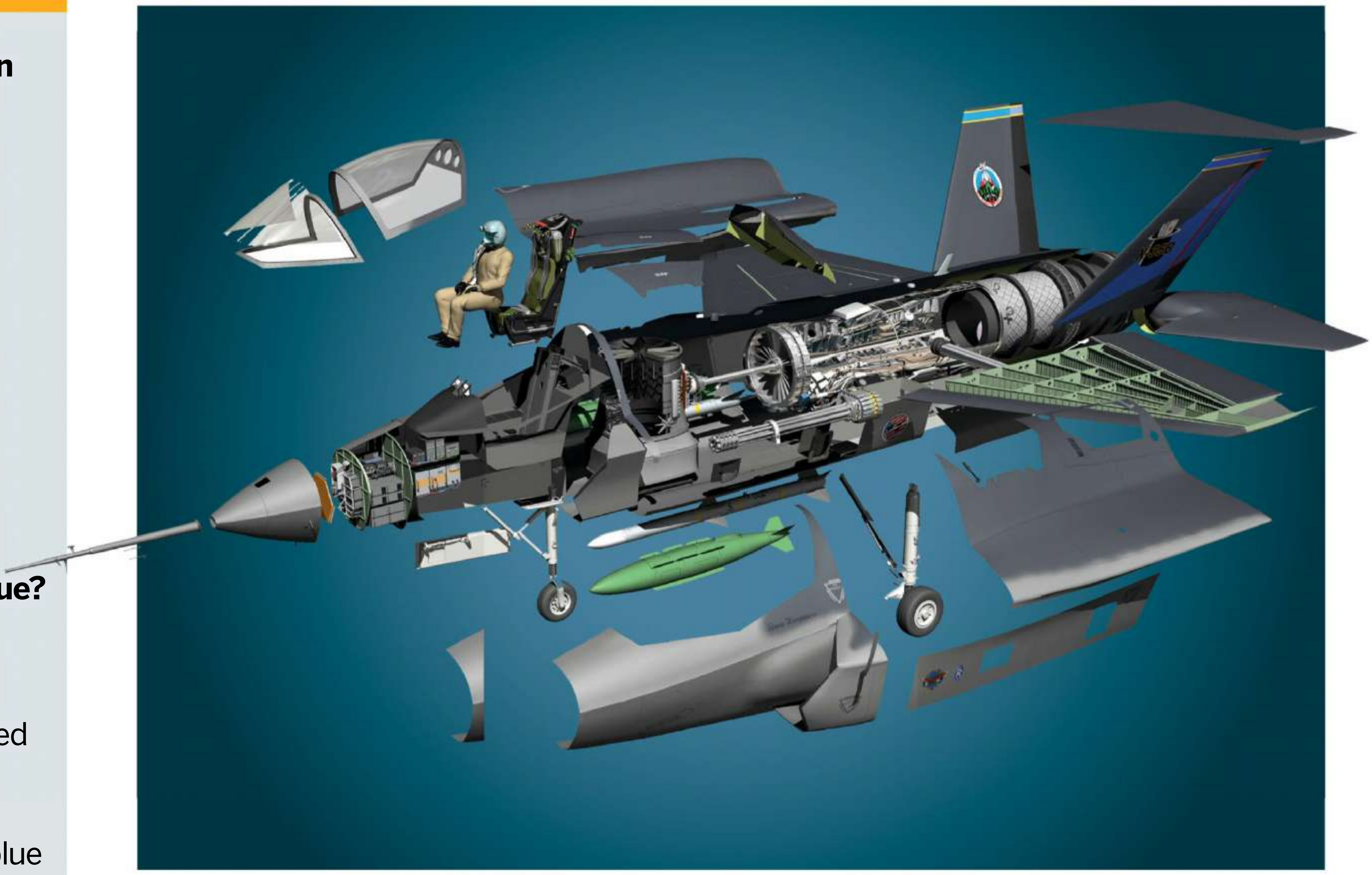
Q4 Approximately how long ago did the first animals live on land?
- ○ 1.1 billion years
- ○ 3.4 billion years
- ○ 930 million years
- ○ 425 million years

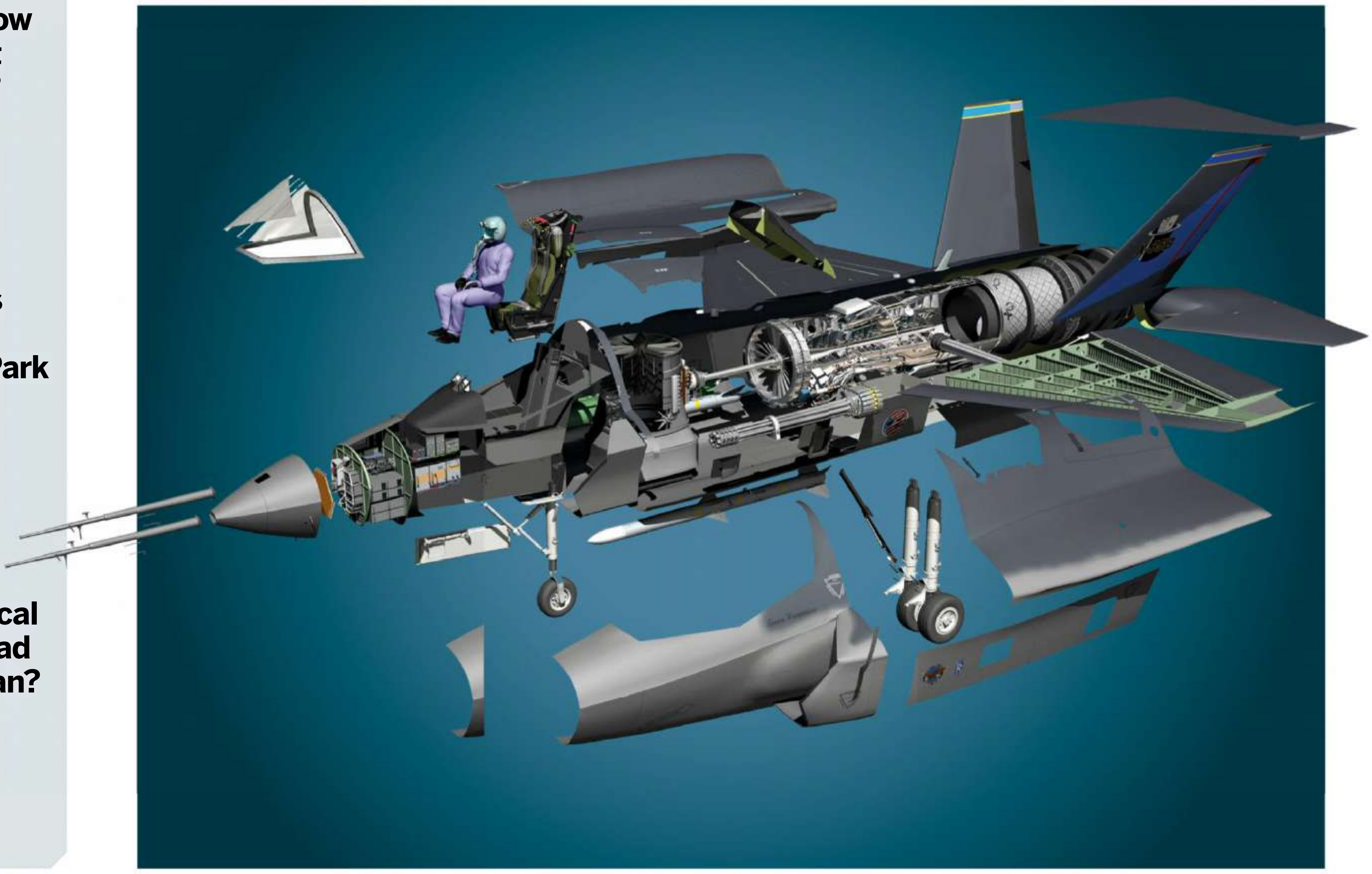
Q5 How many novels are in Michael Crichton's Jurassic Park series?
- ○ 1
- ○ 2
- ○ 3
- ○ 4

Q6 Which mythological beast had a bull's head and the body of a man?
- ○ Chimera
- ○ Minotaur
- ○ Cockatrice
- ○ Basilisk

Spot the difference

See if you can find all six changes between the images below





Sudoku

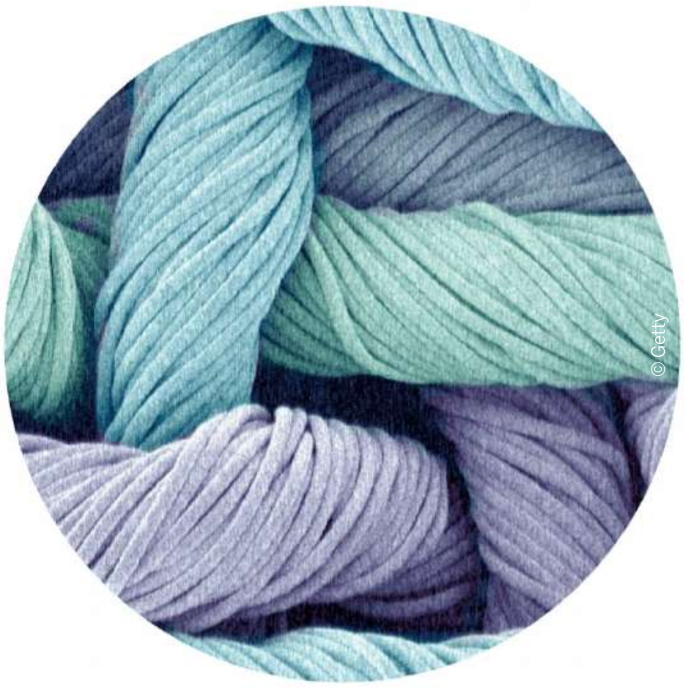
Complete the grid so that each row, column and 3x3 box contains the numbers 1 to 9

EASY

		9	6				5	
	6	2	4				1	
4				8		7		
			5				7	1
1		5		2		3		4
2	4				8			
		6		5				8
	8				3	9	6	
	7				1	5		

DIFFICULT

5	4							9
2			7				4	
9		7	4				2	
	7			6	3		1	
			8		7			
	2		9	5			6	
	9				8	4		2
	1				4			8
7							3	1


© Getty

What is it?

Hint: You're naked without it…

A ....

E	D	H	E	L	I	U	M	P	O	Q	L	A	R	M
H	C	U	E	N	M	Z	X	C	I	C	E	S	F	Y
A	S	D	G	J	M	B	C	X	A	V	E	L	G	T
Q	Y	W	M	R	I	O	P	B	C	Z	C	X	E	H
E	B	V	U	E	Q	L	K	H	A	D	H	E	R	S
A	S	D	Z	Y	D	R	T	I	L	M	B	G	H	U
W	U	D	I	N	Y	I	R	T	U	V	X	Q	C	D
A	T	E	Q	A	V	T	C	U	B	N	B	T	I	O
Y	F	B	B	Y	I	U	A	I	E	Q	S	D	S	R
B	A	R	D	U	F	H	T	Y	N	U	D	R	S	A
L	M	I	P	Y	R	A	S	B	M	E	H	D	A	E
O	N	S	M	I	X	M	N	G	H	T	R	E	R	T
O	V	B	K	B	R	I	E	V	A	W	A	X	U	V
D	Q	S	A	L	O	U	Y	T	E	G	H	X	J	U
O	Y	T	W	O	N	D	E	R	Y	R	U	I	B	L

Wordsearch

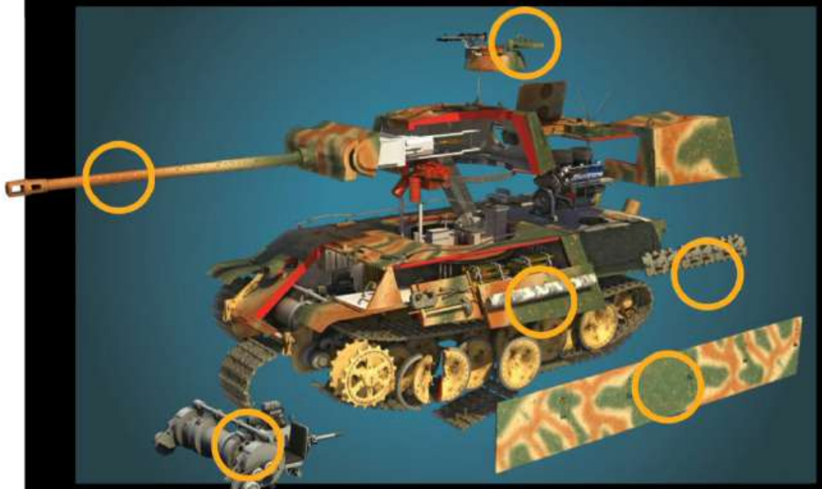
FIND THE FOLLOWING WORDS…

HELIUM
DEBRIS
SKI
JURASSIC
MEDICINE
CATS
LEECH
WONDER
NEBULA
MYTHS
BLOOD
WAVE

Check your answers

Find the solutions to last issue's puzzle pages

SPOT THE DIFFERENCE



QUICKFIRE QUESTIONS

Q1 Meteorite
Q2 Mantle
Q3 It has no air bubbles
Q4 111 metres
Q5 1908
Q6 390 billion

WHAT IS IT? …A TOADSTOOL

© Getty

HOW TO...

Practical projects to try at home

Get in touch

Send your ideas to...

How It Works magazine

howitworks@futurenet.com

@HowItWorksmag

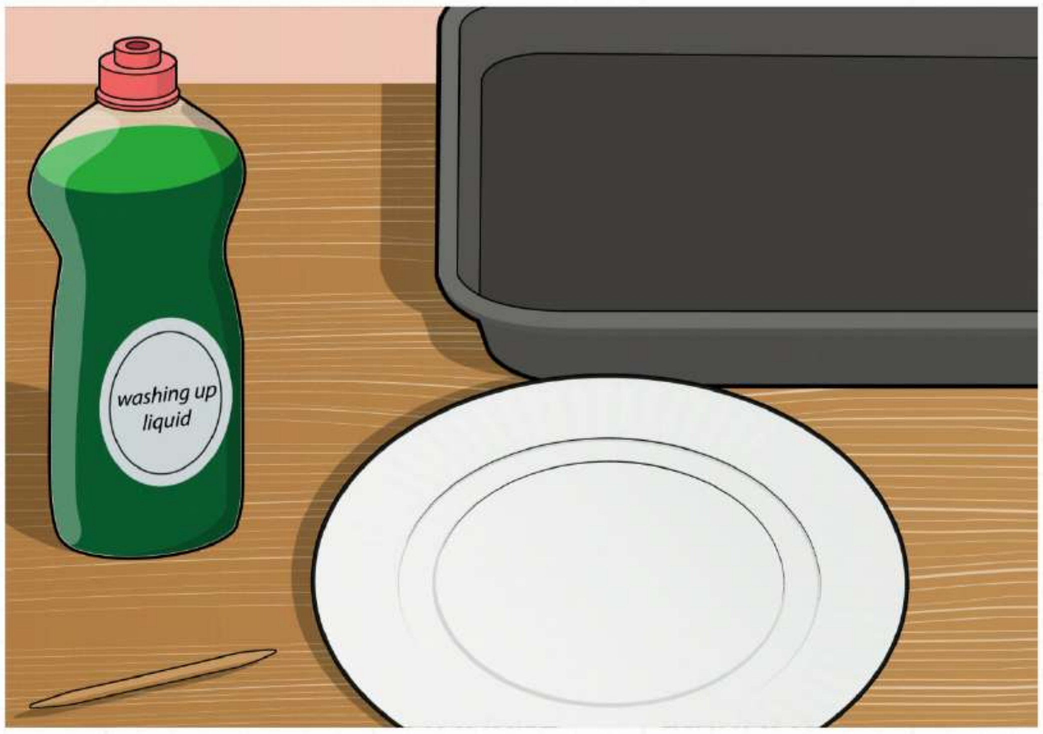
howitworksmag

Make a soap-powered boat

Discover how soap and water interact to propel a vessel across the water

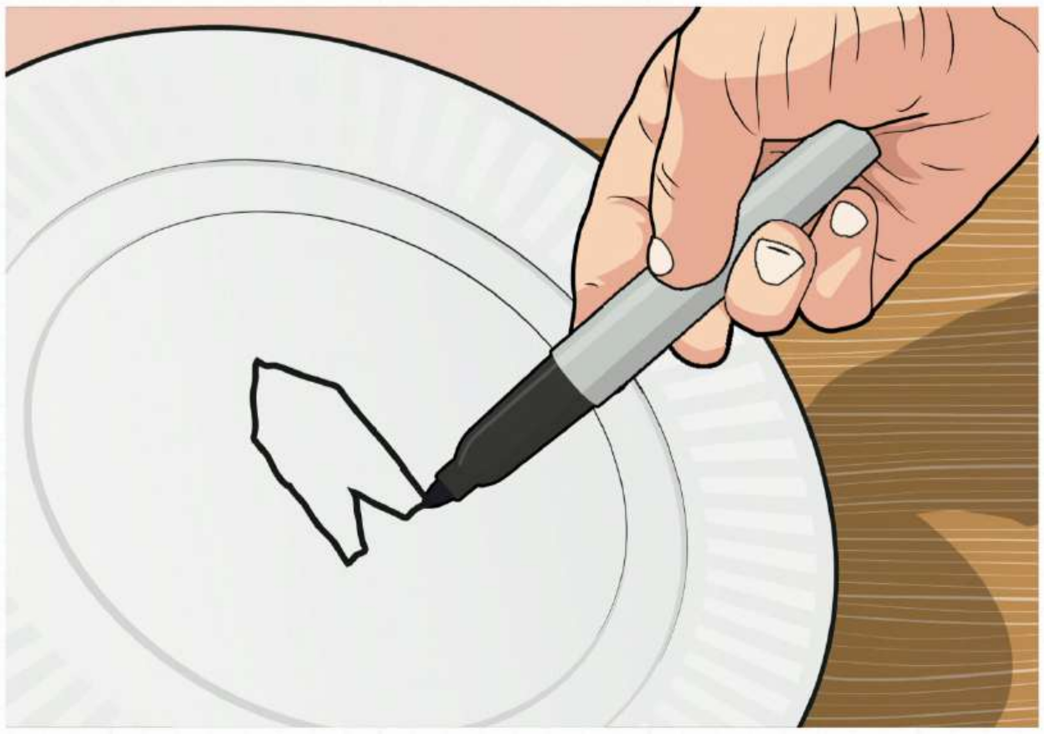
YOU WILL NEED:

- Washing up liquid
- One toothpick
- One polystyrene foam tray or flat piece of cardboard
- One large tray
- Scissors
- Water



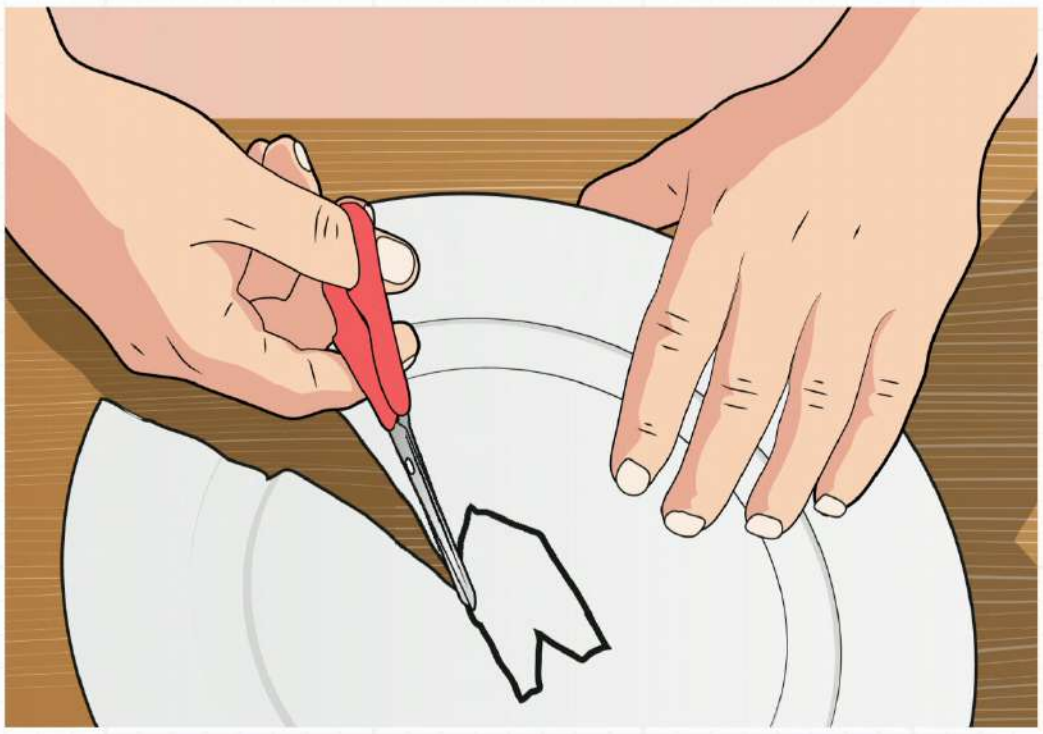
1 Gather your equipment

You may want to try this *How To...* out multiple times to test the effectiveness of the size of your boat or the type of soap. If you plan to add a flagpole or another lightweight decoration, you will need extra materials.



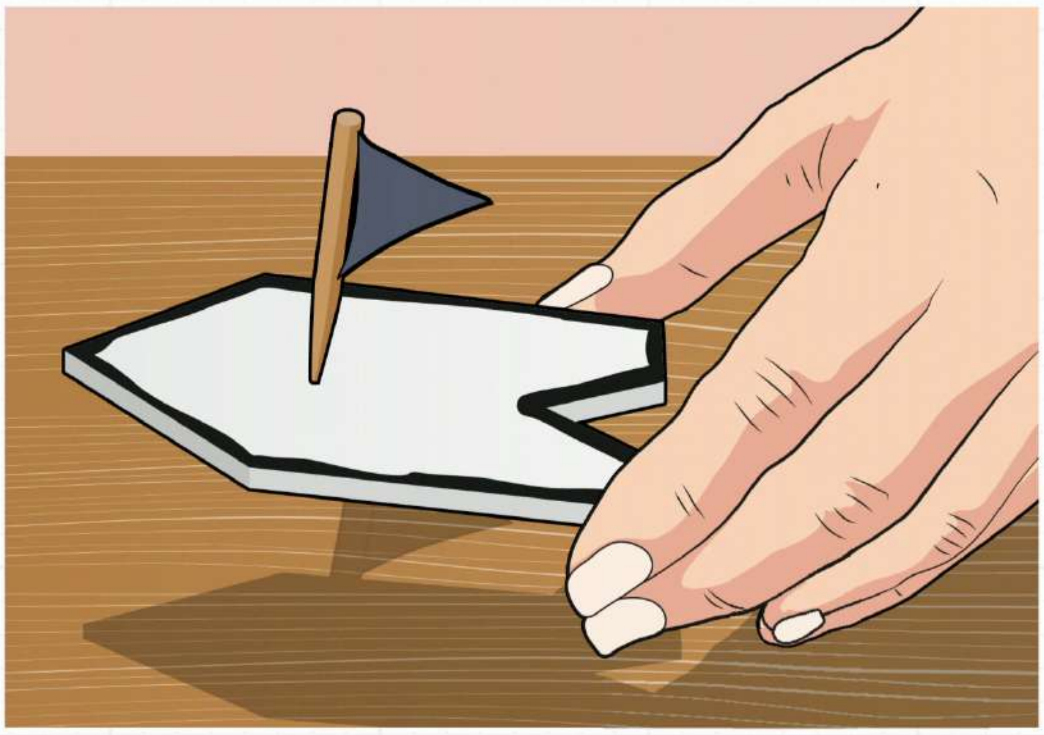
2 Draw your template

Take your foam tray or cardboard and draw this shape on its surface with a pen. You can experiment with different sizes, but for the best results aim to make the shape about five centimetres long.



3 Cut out the boat

Neatly cut around your outline, keeping the lines as straight as possible. The back of the boat might be fiddly, but it's the most important section, responsible for powering your boat.

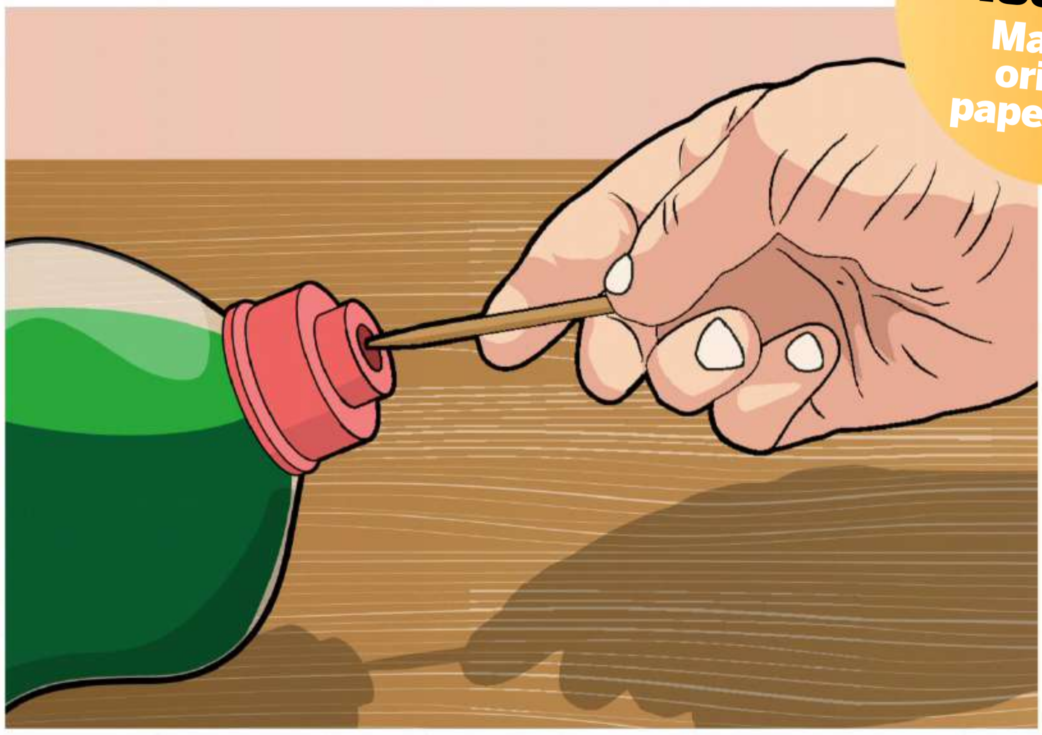


4 Customise your vessel

You can personalise your boat to give it a unique look. Whether you add colour to the surface or construct a toothpick sail to make it three-dimensional, make sure you don't add too much extra weight.

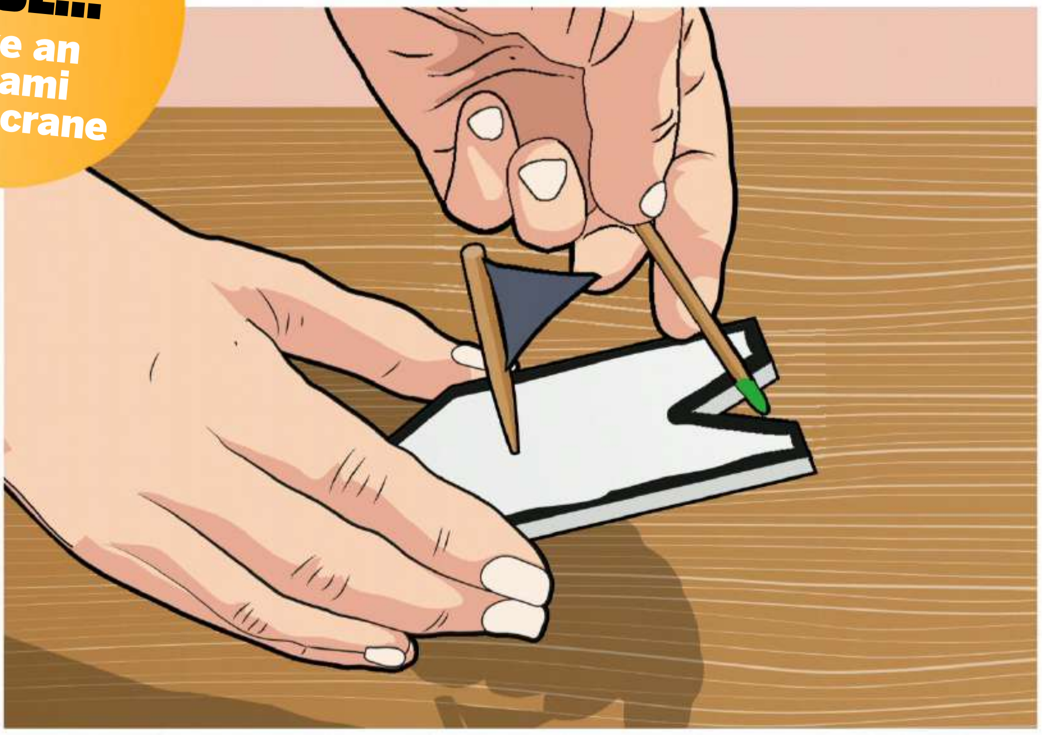
© Illustrations by Ed Crooks

NEXT ISSUE...
Make an origami paper crane



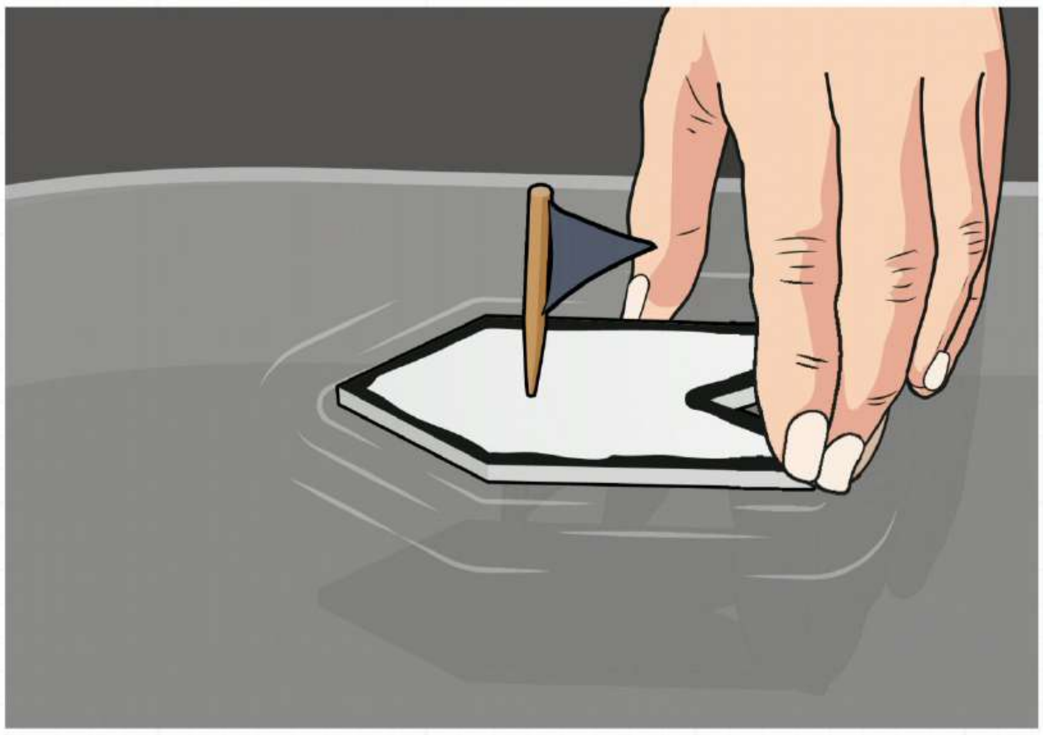
5 Source the fuel

The washing up liquid will serve as your little boat's fuel. Taking your toothpick, dip one end into the soap and get ready to transfer it to the back of the boat.



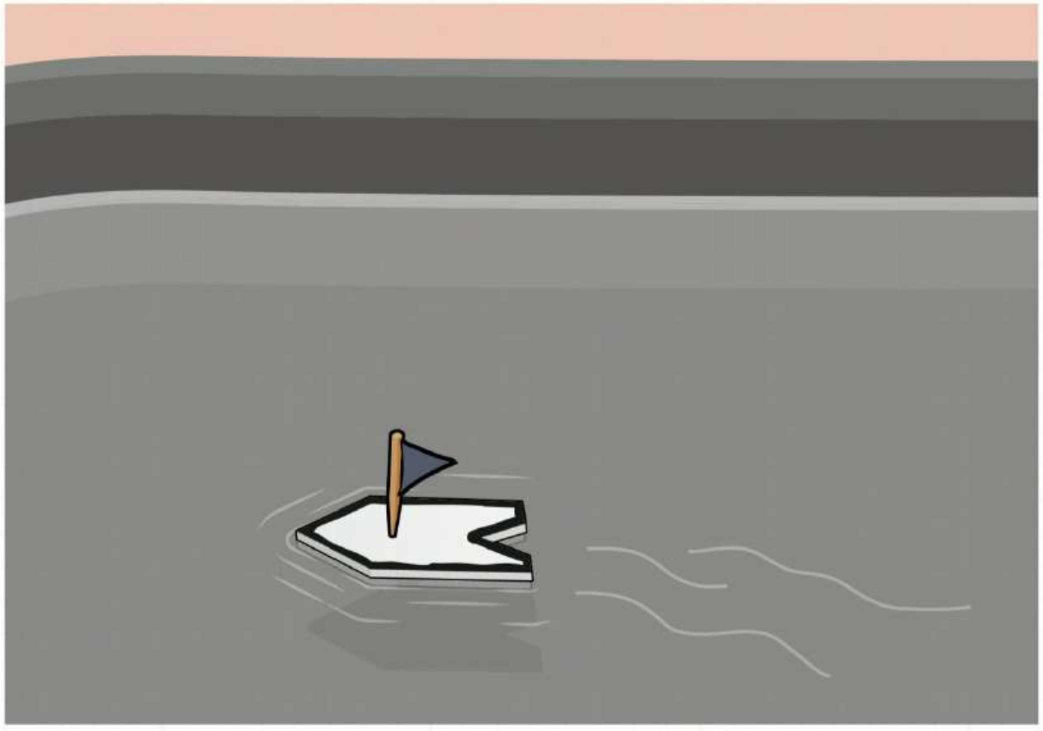
6 Charge it up

Dab the toothpick along the sides of the triangle that you have cut out at the back of the boat. Make sure to only cover these edges, and be careful not to drip washing up liquid near the front of the model in the process.



7 Ready for launch

Fill up your large tray with water and place it onto a flat surface, then take your boat and lower it onto the water. When it is close to the surface, drop it so that it lands flat.

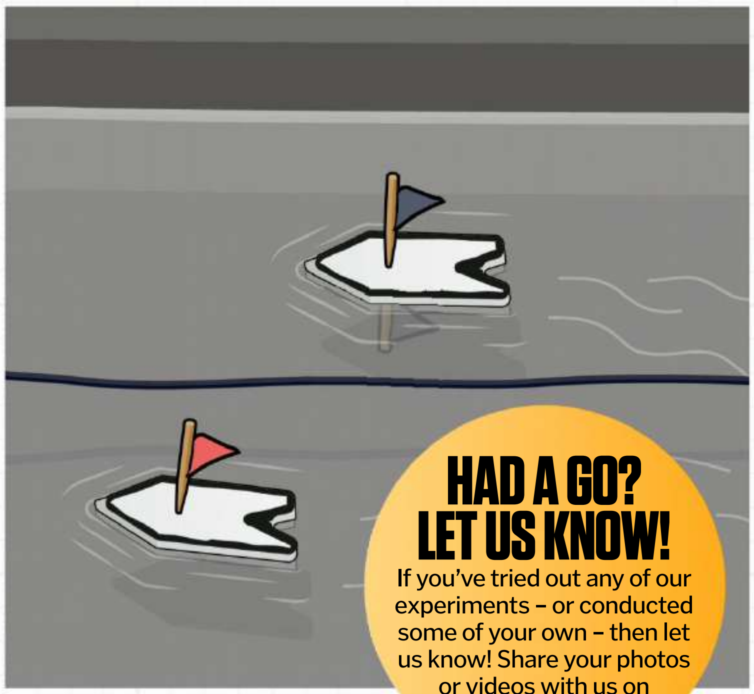


8 Full speed ahead!

Watch what happens next. Using the soap fuel, your boat should speed across the tray for several seconds. Each time you recreate this, you will need to rinse out the tray to remove any remnants of soap.

9 Fancy a race?

Who has designed the fastest boat? To find out, you can create lanes within your tray and race boats with your friends and family. You can let us know who was the champion or send a picture of your favourite boats to us on social media.



HAD A GO? LET US KNOW!
If you've tried out any of our experiments – or conducted some of your own – then let us know! Share your photos or videos with us on social media.

SUMMARY

Water molecules are attracted to each other, forming hydrogen bonds that keep the body of water together. At the surface these molecules have a stronger attraction because they are surrounded by air molecules, which water molecules pull away from. The tendency of water to create this stronger layer at its surface is called surface tension. Soap is a surfactant, meaning it breaks the surface tension. In this experiment, as the bonds between molecules break, they push the boat. Soap is pushed out the back of the boat, as this was the only area where you distributed it, propelling the boat towards the soapless water with a higher surface tension. The boat repeats this reaction as it moves across the surface and comes into contact with more unbroken bonds, keeping it moving.

Disclaimer: Neither Future Publishing nor its employees can accept any liability for any adverse effects experienced during the course of carrying out these projects or at any time after. Always take care when handling potentially hazardous equipment or when working with electronics and follow the manufacturer's instructions.

INBOX

Speak your mind...

Get in touch

If you have any questions or comments for us, send them to:

How It Works magazine @HowItWorksmag

howitworks@futurenet.com howitworksmag

© Getty

'Tele' means distance and 'kinesis' means motion in Greek

Power of the mind

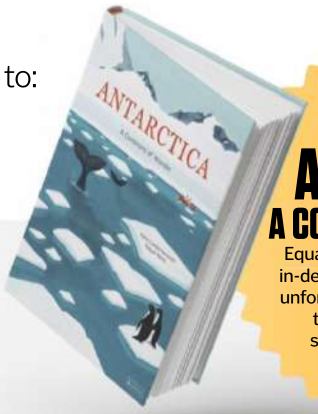
Hi **HIW,**

I was recently trying telekinesis when I managed to bend this fork. I am not joking. I would like to know how I did it. The technique I did involved a bit of meditation, but I somehow managed to do it. Is there any explanation for how I did it?

Yixin Luo

This sounds very impressive, Yixin. However, telekinesis is not something that has enough evidence for scientists to definitively prove or dismiss. Telekinesis doesn't match the laws of physics. The only two forces that have a long enough range to influence an object the size of a fork are gravity and electromagnetism. Gravity would be too weak to bend the fork under ordinary circumstances, while if electromagnetism was involved you would clearly notice it interacting with surrounding objects. There could be new forces that scientists have not yet discovered. However, it is unlikely that a force with that strength or range has not yet been detected.

LETTER OF THE MONTH



WIN!

ANTARCTICA

A CONTINENT OF WONDER

Equal parts thrilling adventure and in-depth exploration, this book is an unforgettable illustrated expedition to Antarctica that is sure to satisfy the boldest bedtime traveller.

www.prestel.com

Home gardening

Hi **HIW,**

I have become a keen indoor gardener during lockdown. I have managed to keep alive and thriving my golden pothos. However, some of its leaves are turning yellow. Why is that?

Eva Magyaricsova

It's great to hear that you've found a new activity to focus on during long periods of time at home. Indoor gardening has become increasingly popular over the last year, and as well as giving you something to do can provide added benefits such as reducing stress levels and maybe even improving air quality in your home.

Many people like to fill their homes with a range of plants, but each has different needs and ways of showing that they are lacking something. The leaves of a golden pothos plant can become yellow quite easily, and for a number of reasons. If the yellow leaves are occurring at the base of the stems, as opposed to the tips, it could be due to its natural growth process. Leaves can become discoloured and fall off in order to make room for new growth.

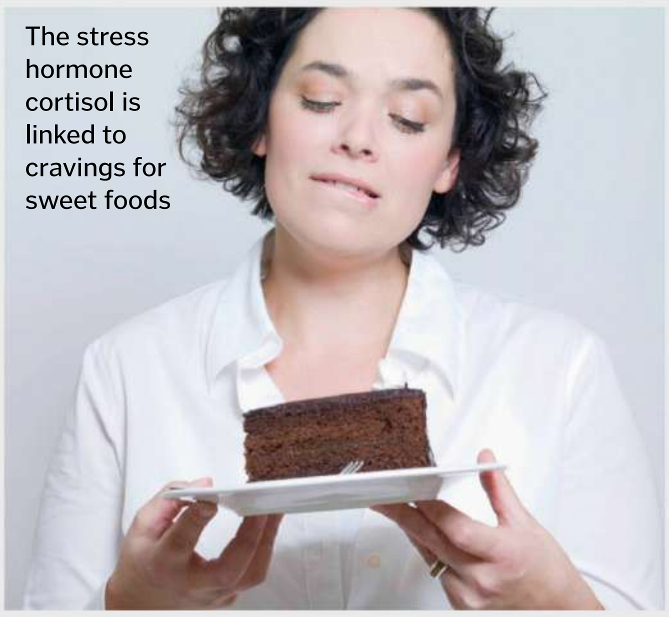
If this isn't the case, there are other possibilities. The most common reason that these plants turn yellow in the home is that they are being overwatered. Make sure that you are allowing the soil to become completely dry again before you water your plant. If you don't think you are overwatering, it could be that the drainage in the plant pot isn't good. There should only be soil in the pot, and the hole at its base needs to be kept free for drainage.

Another problem that is known to cause this yellowing is rotting roots. It is worth checking the roots to eliminate this possibility. If they are white in colour, they are likely to be healthy, while brown roots indicate rotting. Golden pothos can also lose their green colour when placed in cold environments, such as near a drafty window or under air conditioning, but also in areas that are too hot.

Hopefully this will help you to identify the problem, but it's worth checking all possibilities. We would recommend removing any yellowed leaves after doing so – if there are just a few – so that you can see if you have solved the problem. In the meantime, keep up the gardening!

Golden pothos is a vine plant

© Getty


The stress hormone cortisol is linked to cravings for sweet foods

© Getty

The need for food

Dear **HIW,**

What makes you crave certain foods, for example chocolate or carbs? Is it something that's in them?

Chloe

Thank you for your question Chloe. Many readers will have had that intense desire for a specific food, with chocolate being up there as one of the most common. Cravings can be either selective or non-selective. Selective results in a craving for specific foods: there is a theory that this is a sign of your body lacking the nutrients found in these foods, but research shows cravings are purely psychological. If you often eat specific foods while exposed to the same external cues, your brain might make this same link at a later time. An example of this is if you often eat sweet foods, such as chocolate, while watching television. Later on you might experience a craving for these foods as you sit in front of the television. Meanwhile, pregnancy cravings are more likely to be due to a hormone imbalance.

Water for life?

Dear **HIW,**

I know I'm probably being daft, but I read your magazine and other things about life on other planets, and all scientists say for life there has to be water. How do we know that other beings have to have water? Surely it could be possible that they don't need it? Or live in extreme temperatures? Or don't need oxygen?

Mark B

© NASA/JPL-Caltech

The Perseverance rover is looking for ancient life on Mars

These questions have also been queried by scientists, but as we haven't found any alien life to date, the only examples of what we know as 'life' lie on Earth. When space exploration missions search for life, what they are really searching for is 'life as we know it'. It is possible that, as you say, alien life would have very different survival needs, but life is defined by what we have encountered on Earth. Another reason that scientists are keen to find water is because it increases the possibility of a world being habitable for humans.

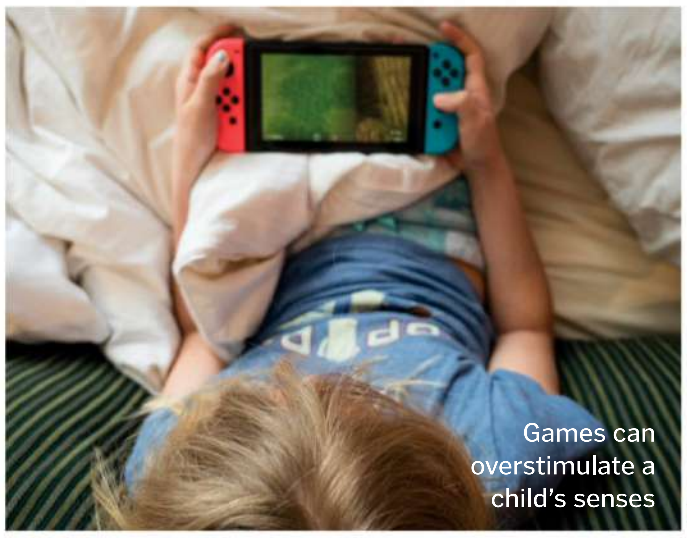
Screen-time stress

Dear **HIW,**

Recently I've been spending a lot of time on electronics. I always find that I am very crabby and irritable after getting off. Is there a logical explanation for this?

Yixin, aged 11

There are many contributing factors to this feeling, and the chances of feeling like this are higher in children. When you use electronics, your brain will release the feel-good chemical dopamine. This occurs during many activities, but electronics appear to release this chemical in very high levels. And it turns out you can have too much of a good thing. Because your body gets used to high levels of dopamine, you become less sensitive to it. That means more is needed to experience pleasure and to stay focused and motivated.


Games can overstimulate a child's senses

© Getty

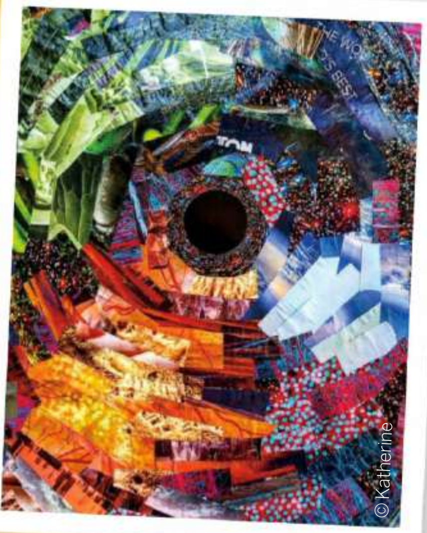
What's happening on...

social media?

This month on Instagram, @art.perspectives shared this post:

Staring deep into the abyss...

I made this piece last year as a dive into the style of collaged materials, sticking to the more simple take of collaged paper. I took inspiration from other work I had seen around and combined the colour variations of magazine strips. For this, strips taken from my ***@howitworksmag*** *science magazines made a perfect array of colours and textures available for this collage. The strips varied in size and I would spend time planning where they would go to blend the colours properly together. This is one of the first collages I ever made and easily my favourite.*


© Katherine

We love this piece of art made by reader Katherine Rogers, and have had fun matching some of the strips with previous issues

NEXT ISSUE...

Issue 152 on sale **10 JUNE 2021**

Available in print from all good newsagents and **magazinesdirect.com**, or as a digital edition for iOS and Android. To enjoy savings on the RRP and to make sure you never miss an issue, check out our subscription offers on pages 24 (UK) and 73 (US).

HOW IT WORKS
Future PLC Quay House, The Ambury, Bath, BA1 1UA

Editorial
Editor **Ben Biggs**
Senior Art Editor **Duncan Crook**
Research Editor **Baljeet Panesar**
Production Editor **Nikole Robinson**
Staff Writer **Scott Dutfield**
Staff Writer **Ailsa Harvey**
Editor-in-Chief **Gemma Lavender**

Contributors
Lauren Eyles, Andrew May, Andy Extance, Jo Elphick, Amy Grisdale

Cover images
ESA, Getty, Nissan

Photography
Alamy, Getty Images, NASA, Science Photo Library, Shutterstock, Wikimedia
All copyrights and trademarks are recognised and respected

Advertising
Media packs are available on request
UK Commercial Director **Clare Dove**
clare.dove@futurenet.com
Senior Advertising Manager **Amanda Burns**
amanda.burns@futurenet.com
0330 390 6036
Account Manager **Garry Brookes**
garry.brookes@futurenet.com
+44 020 3970 4176

International Licensing
How It Works is available for licensing and syndication. To find out more, contact us at **licensing@futurenet.com** or view our available content at **www.futurecontenthub.com**.
Head of Print Licensing Rachel Shaw

Subscriptions
Enquiries **help@magazinesdirect.com**
UK orderline & enquiries **0330 333 1113**
Overseas order line & enquiries **+44 (0)330 333 1113**
Online orders & enquiries **www.magazinesdirect.com**
CRM Director **Louise Dudfield**

Circulation
Head of Newstrade **Tim Mathers**

Production
Head of Production **Mark Constance**
Production Project Manager **Clare Scott**
Senior Advertising Production Manager **Joanne Crosby**
Digital Editions Controller **Jason Hudson**
Production Coordinator **Stephen Turner**

Management
Managing Director **Sarah Rafati Howard**
Chief Content Officer **Angela O'Farrell**
Commercial Finance Director **Dan Jotcham**
Head of Art & Design **Greg Whittaker**

Printed by William Gibbons & Sons Limited
26 Planetary Road, Willenhall, Wolverhampton, West Midlands, WV13 3XB

Distributed by Marketforce, 5 Churchill Place, Canary Wharf, London, E14 5HU
www.marketforce.co.uk
Tel: 0203 787 9001

ISSN 2041-7322

All contents © 2021 Future Publishing Limited or published under licence. All rights reserved. No part of this magazine may be used, stored, transmitted or reproduced in any way without the prior written permission of the publisher. Future Publishing Limited (company number 2008885) is registered in England and Wales. Registered office: Quay House, The Ambury, Bath, BA1 1UA. All information contained in this publication is for information only and is, as far as we are aware, correct at the time of going to press. Future cannot accept any responsibility for errors or inaccuracies in such information. You are advised to contact manufacturers and retailers directly with regard to the price of products/services referred to in this publication. Apps and websites mentioned in this publication are not under our control. We are not responsible for their contents or any other changes or updates to them. This magazine is fully independent and not affiliated in any way with the companies mentioned herein.

If you submit material to us, you warrant that you own the material and/or have the necessary rights/permissions to supply the material and you automatically grant Future and its licensees a licence to publish your submission in whole or in part in any/all issues and/or editions of publications, in any format published worldwide and on associated websites, social media channels and associated products. Any material you submit is sent at your own risk and, although every care is taken, neither Future nor its employees, agents, subcontractors or licensees shall be liable for loss or damage. We assume all unsolicited material is for publication unless otherwise stated, and reserve the right to edit, amend, adapt all submissions.

We are committed to only using magazine paper which is derived from responsibly managed, certified forestry and chlorine-free manufacture. The paper in this magazine was sourced and produced from sustainable managed forests, conforming to strict environmental and socioeconomic standards. The manufacturing paper mill holds full FSC (Forest Stewardship Council) certification and accreditation.

ipso. Regulated

Widely Recycled

FUTURE
Connectors. Creators. Experience Makers.

Future plc is a public company quoted on the London Stock Exchange (symbol: FUTR)
www.futureplc.com

Chief executive **Zillah Byng-Thorne**
Non-executive chairman **Richard Huntingford**
Chief financial officer **Rachel Addison**

Tel +44 (0)1225 442 244

FAST FACTS

Amazing trivia to blow your mind

1.4 BILLION

THERE'S AROUND ONE CAR FOR EVERY 5.5 PEOPLE IN THE WORLD

5,000 TONNES

SPACE DUST WEIGHING THE EQUIVALENT OF 30 BLUE WHALES FALLS TO EARTH EVERY YEAR

$69 MILLION

A PIECE OF DIGITAL ART RECENTLY SET A WORLD-RECORD AUCTION PRICE

1948

THE UK'S NATIONAL HEALTH SERVICE (NHS) WAS LAUNCHED IN THIS YEAR ON 5 JULY

1%

MARS HAS A TINY PERCENTAGE OF EARTH'S ATMOSPHERIC VOLUME

RYE IS THE MOST COMMON ALLERGY IN THE US, CLOSELY FOLLOWED BY DUST MITES

THE VIKINGS HAD GOOD PERSONAL HYGIENE AND WERE WELL-GROOMED

2,300 SQUARE MILES

THE GIANT ANTARCTIC ICEBERG A68 COVERED A HUGE AREA BEFORE IT MELTED

3.5 METRES

THE WANDERING ALBATROSS HAS THE LARGEST WINGSPAN OF ANY BIRD

7.5 CENTIMETRES

HAWAII MOVES A LITTLE BIT EAST EVERY YEAR, CLOSER TO ALASKA

THE QWERTY KEYBOARD USED TODAY WAS DESIGNED TO SLOW DOWN TYPING

COVID

WHO IS MOST AT RISK? WHAT CAN PREVENT IT?

thomaswimberly.com @thomaswimberly @thomaswimberlystudios

PLEASE TAKE THE SURVEY

qmul.ac.uk/covidence

Queen Mary University of London

THE UNIVERSITY of EDINBURGH

Swansea University Prifysgol Abertawe

QUEEN'S UNIVERSITY BELFAST

SIGN UP

PAPER LOVES TREES

European forests, which provide wood for making paper,
paper packaging and many other products, have been
growing by 1,500 football pitches every day!

Discover the story of paper
www.lovepaper.org

Source: Forest and Agricultural Organisation of the United Nations (FAO), 2005 - 2015
European Forests: EU27 + Norway, Switzerland and the UK

LOVE
PAPER